Fishes of the Thomsen River, Banks Island, Northwest Territories

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by

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ABSTRACT

Stephenson, S.A. 2010. Fishes of the Thomsen River, Banks Island, Northwest Territories. Can. Manuscr. Rep. Fish. Aquat. Sci. 2944: vi + 44 p.

During sampling in the summer of 2000 and 2001, a total of 24 Lake Trout (*Salvelinus namaycush*), 217 Arctic Char (*S. alpinus*) (58 adult and 159 juvenile or young-of-the-year), 152 Least Cisco (*Coregonus sardinella*) (146 adult and 6 young-of the-year) and 139 Ninespine Stickleback (*Pungitius pungitius*) were captured by gill net, seine or electroshocking within the Thomsen River and it's tributaries on northern Banks Island in Aulavik National Park.

No new species were added to those known from the Thomsen River. Lake Whitefish (*Coregonus clupeaformis*), reported only once from the upper watershed, the freshwater form of the Fourhorn Sculpin (*Myoxocephalus quadricornis*) and the Deepwater Sculpin (*M. thompsonii*), were not captured. Due to capture locations, all previous records of the Deepwater Sculpin are believed to have been marine Fourhorn Sculpin. Lake Herring (*Coregonus artedi*), reported during one survey, are now known to have been misidentified Least Cisco.

Examination of Lake Trout suggests populations dominated by large, old fish that do not reproduce annually. Preliminary strontium analysis showed that Arctic Char exhibit anadromous and non-anadromous forms. Arctic Char exhibit a relatively unimodal age distribution and also do not reproduce annually. Food habit studies reveal opportunistic feeding is the norm for Lake Trout, Arctic Char and Least Cisco although feeding by all species is highly correlated with insect hatches.

Due to their size and dominance within most river pools, Lake Trout may control the entry of other fish into their adult populations. Disruption of this structure through the removal of large Lake Trout could result in a new fish community that may not resemble the current and might not return to a new equilibrium for years.

Commercial or large scale subsistence fishing should be discouraged on the Thomsen due to the slow growth, overall small populations and the ease with which large numbers of fish could be captured. The few recreational anglers that visit the Thomsen River are unlikely to have a large negative impact on the resource, but should still be encouraged to limit their harvest.

Key words: Thomsen River, Banks Island, Lake Trout, Arctic Char, Least Cisco, Ninespine Stickleback, Fourhorn Sculpin, zoogeography, strontium.

RÉSUMÉ

Stephenson, S.A. 2010. Fishes of the Thomsen River, Île Banks (Territoires du Nord-Ouest) au Canada. Rapp. man. sci. halieut. aquat. 2944: vi + 44 p.

Lors d'activités d'échantillonnage menées aux étés de 2000 et 2001, on a capturé un total de 24 touladis (*Salvelinus namaycush*), 217 ombles chevaliers (*S. alpinus*) (58 adultes et 159 juvéniles ou jeunes de l'année), 152 ciscos sardinelles (*Coregonus sardinella*) (146 adultes et 6 jeunes de l'année) et 139 épinoches à neuf épines

(*Pungitius pungitius*) par filet maillant, senne ou électrochocs dans la rivière Thomsen et ses tributaires du parc national Aulavik, au nord de l'île Banks.

Aucune nouvelle espèce ne s'est ajoutée aux espèces connues de la rivière Thomsen. On n'a capturé aucun grand corégone (*Coregonus clupeaformis*), signalé une seule fois dans le bassin hydrographique supérieur, et aucun représentant de la variété dulçaquicole du chaboisseau à quatre cornes (*Myoxocephalus quadricornis*), le chabot de profondeur (*M. thompsonii*). Compte tenu de l'endroit des captures, on croit que tous les enregistrements antérieurs de chabot de profondeur étaient des chaboisseaux à quatre cornes marins. On sait maintenant que les ciscos de lac (*Coregonus artedii*) signalés lors d'un levé étaient des ciscos sardinelles mal identifiés.

L'examen des touladis laisse croire que les populations sont dominées par de gros et vieux poissons qui ne se reproduisent pas tous les ans. L'analyse préliminaire du strontium montre que l'omble chevalier se manifeste sous des formes anadrome et non anadrome. L'omble chevalier montre une répartition d'âge relativement unimodale et ne se reproduit pas chaque année non plus. Les études sur les habitudes alimentaires révèlent que l'alimentation opportuniste est la norme pour le touladi, l'omble chevalier et le cisco sardinelle, même si l'alimentation de toutes les espèces est fortement corrélée à l'éclosion des œufs d'insecte.

En raison de sa taille et de sa dominance dans la plupart des fosses, le touladi peut contrôler l'entrée d'autres poissons dans ses populations adultes. La perturbation de cette structure par l'enlèvement des gros touladis pourrait entraîner la création d'une nouvelle communauté de poissons ne ressemblant pas à la communauté actuelle et susceptible de ne pas trouver un nouvel équilibre avant des années.

La pêche commerciale et la pêche de subsistance à grande échelle dans la rivière Thomsen doivent être découragées en raison de la croissance lente, des populations généralement petites et de la facilité avec laquelle de grandes quantités de poissons pourraient être prises. Les quelques pêcheurs sportifs qui visitent la rivière Thomsen ont peu de chances d'avoir une grande incidence négative sur la ressource, mais on doit néanmoins les encourager à limiter leurs prises.

Mots-clés : rivière Thomsen, île Banks, touladi, omble chevalier, cisco sardinelle, épinoche à neuf épines, chaboisseau à quatre cornes, zoogéographie, strontium.

INTRODUCTION

The fisheries resources of rivers have generally not been as intensively studied as those of lakes. This is due to the greater commercial and recreational use of lakes and, therefore, their higher perceived value. Large rivers do sometimes support large populations of fish species that utilise rivers for a major portion or all of their life and the river itself acts as a surrogate for lacustrine habitat (Stephenson and Momot 1991). In the Arctic, several large lakes long used for commercial, subsistence or recreational fisheries have been well studied (*e.g.*, Johnson 1983), but few Arctic rivers have been studied in any detail. Those that have are generally single species rivers that support populations of Arctic Char (*Salvelinus alpinus*) (*e.g.*, Kristofferson and Sopuck 1983). Multi-species rivers on the islands of the Canadian Arctic Archipelago are relatively rare and become rarer with increasing latitude and virtually no information exists on the species or the interactions of the species within them. Few of these rivers remain lightly or completely unexploited.

The Thomsen River on northern Banks Island has been described as the most northerly multi-species river in North America (Zoltai *et al.* 1980). Due to its' remote location and near pristine state, it is a unique area to examine riverine fish stocks and their interactions. Rivers north of the Thomsen on other Arctic islands [*e.g.*, Melville and Bathurst islands (Stewart and Bernier 1982)] possess a fish assemblage of Fourhorn Sculpin (*Myoxocephalus quadricornis*) and Arctic Char or only Arctic Char. At least three species, Lake Trout (*Salvelinus namaycush*), Least Cisco (*Coregonus sardinella*) and Ninespine Stickleback (*Pungitius pungitius*), reach their known northern limit of distribution in the Thomsen River.

All of the approximately 120 permanent residents of Banks Island live in the community of Sachs Harbour (71°59' N, 125°14' W) on the southwest corner of the island. Except for seasonal trips to nearby areas, most fish harvesting (almost all of it subsistence in nature) takes place near the community in the Sachs River watershed (Manning 1953a, Stephenson, unpublished data). With few exceptions (*e.g.*, Babaluk *et al.* 1997), published information on fish distribution and analysis of biological characteristics of fish stocks in most watersheds on the island are absent.

Little use is made of the Thomsen River area by residents of Sachs Harbour due to its distance (approximately 250 air km northeast) from the community. The area has reportedly never been permanently inhabited or used for hunting, trapping or fishing in recent times (Usher 1966, 2002; Zoltai *et al.* 1980). There has been little need to manage Thomsen River fish stocks and hence, except for those in support of establishing a national park in the area or examining fishing potential, few studies have been carried out. However, examination and understanding of unexploited fish stocks in the Thomsen River may provide the information useful for setting goals with regards to the characteristics desired to indicate recovery of overexploited riverine stocks in other areas. Understanding the Thomsen River fisheries also supports management of that part of the river encompassed by Aulavik National Park.

In this manuscript I: (1) summarise historic fish capture information for the Thomsen River watershed and Banks Island in general (2) present new information on fish species collected during survey work in the Thomsen River during 2000 and 2001, (3) briefly present information on the zoogeography of fishes of the Thomsen River and Banks Island in general, and, (4) make recommendations for additional research.

Study Area

Banks Island is the western most island in the Canadian Arctic Archipelago and has an area of approximately 70,000 km^2. Aulavik National Park encompasses approximately 12,725 km^2 of the north-eastern/north-central part of the island (Fig. 1). The park, established in 1992, receives few visitors each year due to its' remote location and the high costs associated with travel to the area. Due to limited landing areas, tourists that visit the park often canoe the Thomsen beginning from a drop off point at an area called Green Cabin (73°13'49" N, 119°32'12" W) slightly north of the mouth of the Sarfarssuk River [also called the Chebyshev River (Anderson and Durrant 1976)]. Limited landing areas again generally restrict pickup of parties to an area at the mouth of the Muskox River (73°49' N, 119°53' W) or to the head of nearby Castel Bay (74°00' N, 119°42' W) approximately 110 km downstream of Green Cabin. Including Parks Canada staff the number of annual canoe parties in the park rarely exceeds four and in some years tourists do not visit the park (A. Lawrence, Parks Canada, pers. comm., 2000). Due to the limited number of tourists that may or may not fish while in the park as well as very infrequent use of the area by residents of Sachs Harbour, Thomsen River fish stocks remain almost completely unexploited.

Approximately one-half of the Thomsen River watershed is within the boundaries of Aulavik National Park. While the Thomsen River is the longest river on the island (235 km), it has the second largest watershed (9,325 km^2), being surpassed by the Bernard River (10,285 km^2) which drains to the west of the island (Sutherland and Golke 1978). The Thomsen watershed is characterised by rolling hills, relatively deep channels and large lakes in its headwater areas with wide, braided channels and low banks near its mouth in Castel Bay. Middle sections of the river (*i.e.*, Whitesand Creek to Muskox River) alternate between deep pools and shallow riffle areas and contain numerous small lakes and ephemeral streams within the river's flood plain. Waters are typically clearest in headwater areas and become more turbid near the mouth. Zoltai *et al.* (1980) described the physiography of the Thomsen River from 73° to 74° N as the Thomsen River Plain: an area with gently rolling, low hills and intervening plains generally below a 150 m contour modified by glacial action and proglacial lakes.

The Thomsen River and its' tributaries are fed almost exclusively by spring runoff after which time the water level drops quickly (Anderson and Durrant 1976). Late summer flows may be reduced to as little as 2% of spring discharge flows (Zoltai *et al.* 1980) leaving some areas of the river difficult to navigate by canoe (Manning 1953b, Wilkinson *et al.* 1977) and seemingly impassable to fish movement. Generally, the Thomsen River breaks up in the third week of June and base flows are reached within a month (Anderson and Durrant 1976). Initial runoff in early June is over the ice and ice jams frequently block the entire river (Anderson and Durrant 1976). Large, deep lakes tributary to the Thomsen River often possess partial or complete ice cover until late July and may remain partially or completely ice covered in some years (*e.g.*, Sutherland and Golke 1978, Baker 1988). In some years, even small lakes remain ice covered well into late July and may remain ice covered all year.

Climate throughout the entire island is severe and tends towards Arctic Desert inland while Arctic Maritime climate predominates along the coast (Zoltai *et al.* 1980). Winters are long with mean monthly temperatures below 0°C from September through May. Summers are short and cool with mean maximum temperatures between 5 to 10°C from June through August (Zoltai *et al.* 1980, Anderson and Durrant 1976). Climate data from

Environment Canada suggest a mean monthly temperature at Green Cabin from June through August (1999-2001) of near 6°C (F. Svistovski, Environment Canada, pers. comm., 2002). There is little precipitation; the annual mean being less than 10.0 cm and the majority of this falling as snow during late winter (Zoltai *et al.* 1980). Data from the Green Cabin climate station suggests a monthly average of 10.0 mm of precipitation from June through September (1999-2001) (F. Svistovski, Environment Canada, pers. comm., 2002) which is not enough to appreciably raise water levels in the river.

Compared to the mainland (approximately 120 km to the south), Banks Island possesses a sparse fish fauna. Although the island possesses a severe climate, the marine barrier and distance from glacial refugia may have had more to do with the limited ichthyofauna than the islands' environment. None of the fish species known from Banks Island are considered to be primary freshwater species (Crossman and McAllister 1986) and therefore all exhibit at least some temporary saltwater tolerance. Nearby Victoria Island, approximately three times the area of Banks Island, much closer to the mainland and with a great number of large lakes which are generally absent from Banks Island, possesses a similarly small fish fauna, but also includes the Arctic Cisco (*Coregonus autumnalis*) (Scott and Crossman 1973, Crossman and McAllister 1986).

Previous Surveys and Known Fish Distribution on Banks Island

Studies examining the distribution of the fishes of Banks Island have been limited either to brief surveys, mainly near the mouths of rivers, or to longer-term studies focussed on areas of greatest subsistence use, primarily near the community of Sachs Harbour. The remote location of the island itself, the expense and difficulty in travelling around or across it (*e.g.*, Manning 1953b) and the relatively short field season have all affected the design of the few studies which have taken place. Aside from studies wanting to know what was in the Thomsen River due to a plan to include much of it within the then proposed Aulavik National Park boundaries (*i.e.*, Wilkinson *et al.* 1977; Zoltai *et al.* 1980), there have been few attempts to document the species within the rivers of the island other than to satisfy basic curiosity about the area. Most fisheries studies have simply reported the capture of a species and information which would allow long-term comparison on food habits, growth, relative abundance or sex ratios have either not been recorded during these studies or not been presented in the resulting reports.

The first written records reporting any fish on the island appear to be those from the crew of the ill fated *Investigator* who obtained a few "trout", probably Arctic char, from a small lake near Ballast Beach on the north coast of the island in 1851 (Manning 1953a). Arctic Char were first placed on the list of fish from the Thomsen River in 1953 when Manning (1953a) reported their capture in the lower Thomsen River and nearby Castel Bay. Lake Trout, Least Cisco and "sculpins" were also captured in Castel Bay (Manning 1953a) (Table 1). Manning (1953a) also reported that Inuit residents of the community of Sachs Harbour reported the capture of Arctic Char, Lake Trout and "whitefish" (species unknown) from the Sachs River. Hunter (1963) captured Arctic Char and added Lake Trout and Least Cisco to the Thomsen River fish list as well as to several other locations on the island. Hunter (1963) also reported the capture of Deepwater Sculpin (*Myoxocephalus thompsonii*) and added it to the list of Thomsen River fishes. Sutherland and Golke (1978) probably contributed the greatest amount of knowledge about the overall distribution of the fishes of Banks Island with their island wide survey in 1976. Visiting 25 locations across the island and using both gill and seine nets, they captured Arctic Char, Lake Trout, Least Cisco, Ninespine Stickleback and "sculpins" and also

reported Lake Whitefish (*Coregonus clupeaformis*) in the Sachs River. Sutherland and Golke (1978) captured Lake Trout, Arctic Char, and Least Cisco and reported the first capture of Ninespine Stickleback from the Thomsen River (Table 1). Wilkinson *et al.* (1977) carried out gill netting using multi-mesh nets within the lower Thomsen River and a few lakes in the watershed and captured four fish species, misidentifying the Least Cisco as Lake Herring (*Coregonus artedi*); a species never reported anywhere on the island before or since. Wilkinson *et al.* (1977) provided some basic biological information (*e.g.*, length, weight and sex) on many of the species captured, although they concentrated primarily on Arctic Char. Baker (1988) examined the two largest lakes on the island, one draining into the Thomsen River, the other draining to the east into Prince of Wales Strait, and added the Lake Whitefish as a possible inhabitant of the Thomsen watershed. Baker's (1988) study provided more information than any previous studies about the biological characteristics of the Arctic Char population although data on abundant Lake Trout was not recorded. The purpose of Baker's (1988) study was to collect data to evaluate the feasibility of establishing a sports or commercial venture for Arctic Char in one or both of these lakes.

Therefore, most surveys have typically been brief and suggest that six fish species may inhabit the Thomsen River; the same number as the total known from the entire island. Arctic Char, Lake Trout and Ninespine Stickleback appear to be widely distributed on the island while Least Cisco are known only from a few larger rivers. Lake Whitefish may occur in two rivers while sculpins, probably all Fourhorn Sculpin (see section below), appear to be rare and confined primarily to river mouths. While two species of Pacific salmon, Pink Salmon (*Oncorhynchus gorbuscha*) and Sockeye Salmon (*O. nerka*), have been reported from the Sachs River, they are considered strays rather than permanent inhabitants (Stephenson 2006).

METHODS

The Thomsen River was surveyed from June 25 to July 24, 2000 and from July 7 to 17, 2001. The majority of fish captures were made while traveling downstream by canoe from a base camp at Green Cabin to pick-up locations near the mouth of the Muskox River (2000) or Castel Bay (2001). Additional fish were captured near Green Cabin between August 11 and 17, 2000 and in Nangmavik Lake (west of the Thomsen River – not reported here) between July 25 and 29, 2001.

Surface water temperatures were recorded with handheld thermometers at each capture site. When gill nets were used, the maximum and minimum depth of water in which the net was set was recorded. Additional data recorded included length of fishing time, weather at time of setting net, approximate channel width and a qualified description of current, water clarity and bottom substrates in the fishing area.

Relative abundance, calculated as;

Total catch of species "x" / Total catch of all species x 100

was calculated for both years of the survey using only the downstream gill net portion of the survey data. Catch-per-unit-effort (CPUE) was calculated separately for the downstream portion of the survey in both years as well as the August 2000 sampling period. CPUE was calculated for each species as the number of fish captured per 100 m

of gill net per 24 hour period.

Sampling gear consisted of index gill nets (51-140 mm stretched mesh multi-filament in 12.5 mm increments x 6.1 m long panels) or 76 mm stretched mesh (22.9 m long, used only twice in 2000). Only index gill nets were utilised in 2001. Seine nets (6.4 mm mesh by 1.8 m x 9.1 m) were used in tributary streams and quiet portions of the river in 2000. In place of the seine, a Smith-Root 15-B backpack electroshocker was used for small fish capture in 2001. Most small fish captured by seine or electroshocking were retained while larger individuals in the sample which were positively identified were released.

Fish captured in gill nets that were either retrieved dead or sacrificed were sampled for; weight to the nearest 2.0 g (fish under 300 g) or 50.0 g (fish over 300 g) using Pesola or Chatillon spring scales, fork length (FL) (in mm), sex and maturity and stomach contents. Ageing tissues were removed from all adult fish (otoliths from dead fish, scales and/or fin rays from released fish) although ultimately, only otoliths were used for ageing.

Fulton's condition factor ("K") (Ricker 1975) was calculated using the formula;

$$\text{weight in g} \times 10^5 / \text{length in mm}^3.$$

Although condition factor can vary greatly depending on sex and spawning condition or when feeding last occurred (Ricker 1975), it is a useful parameter when comparing populations or examining variation within populations, especially when the fish have been captured during the same seasonal period.

Large Lake Trout (>800 mm FL) and Arctic Char (>755 mm FL) were released when possible. Lake Trout that were released and too large for weighing due to possible harm to the fish or limits of the spring scale were measured for girth to determine approximate weight. The formula;

$$\text{length (in inches) (girth (inches) x girth (inches))/ 800}$$

was used to approximate weight (in grams) and to estimate condition factor.

Stomachs from all fish dead sampled in 2001 were preserved in 10% formalin and the contents identified in the laboratory using a dissecting microscope. Invertebrate keys were used to key all items to order or family. Frequency of occurrence was calculated as the proportion of each fish species with a particular food item in its stomach. All stomachs were examined in the field during 2000, but only the largest or most clearly visible items were identified and recorded into gross taxonomic categories.

The otoliths of 11 randomly selected Arctic Char were examined to determine the strontium concentration to establish if any of these fish were anadromous. Otolith microchemistry can provide details on the environments occupied during a fish's life and help to determine life history type (*e.g.*, Secor *et al.* 1995). Seawater, on average, contains 8.0 mg per litre strontium whereas freshwater contains only 0.1 mg per litre (Rosenthal *et al.* 1970). Differences in strontium levels in fresh- and seawater are therefore reflected in fish otolith composition (Halden *et al.* 1995).

During 2000 and 2001, tissue samples were collected from 33 adult Arctic Char and 21 adult Lake Trout for later genetic analyses.

RESULTS AND DISCUSSION

Species Captured

No species new to the known ichthyofauna of the Thomsen River or Banks Island were captured during the 2000 and 2001 survey. Lake Whitefish and Deepwater Sculpin were not captured in either year. A total of 67 Least Cisco (50 aged), 11 Lake Trout (6 aged) and 38 Arctic Char (30 aged) were captured in gill nets in 2000. Specimens not aged in 2000 were either released (3 Least Cisco, 3 Lake Trout, 5 Arctic Char) or did not have interpretable ageing tissues (14 Least Cisco, 2 Lake Trout, 3 Arctic Char). Of these specimens, 44 Least Cisco, nine Lake Trout and 13 Arctic Char were captured during the downstream portion of the survey while the remainder (20 Least Cisco, 2 Lake Trout and 25 Arctic Char) were captured at a base camp near Green Cabin in August. One Lake Trout captured early in the survey did not have its' length recorded and is not included in any analysis.

Two Fourhorn Sculpin (*Myoxocephalus quadricornis*) (not aged), 79 Least Cisco (70 aged), 13 Lake Trout (8 aged) and 20 Arctic Char (14 aged) were captured in gill nets in 2001. Specimens not aged in 2001 were either released (3 Lake Trout, 5 Arctic Char) or did not have interpretable ageing structures (9 Least Cisco, 2 Lake Trout, 1 Arctic Char).

Ninety-five Ninespine Stickleback (29-59 mm FL) were collected by seine or minnow trap at seven locations in 2000 of which 75 were retained. Seventy-four juvenile or young-of-the-year (YOY) Arctic Char (22-96 mm FL) were captured by seine at two locations in 2000 of which 64 were retained. Six YOY Least Cisco (17-23 mm FL and not included in the 2000 Least Cisco total) were collected by hand and retained. Electroshocking at three locations during 2001 captured 85 juvenile and YOY Arctic Char (37-99 mm FL), all of which were preserved. Forty-four Ninespine Stickleback (20-64 mm FL) were captured at two locations and retained.

Relative Abundance

Relative abundance indices of each species for 2000 and 2001 as calculated during the downstream portion of the survey using gill net captures were (respectively): Lake Trout - 13.6 and 11.4, Arctic Char - 19.7 and 17.5 and Least Cisco - 66.7 and 69.3. Relative abundance of Fourhorn Sculpin in 2001 was 1.8% of the total catch.

Catch-Per-Unit-Effort (CPUE)

CPUE for 2000 was 2.25 Lake Trout, 3.25 Arctic Char and 11.0 Least Cisco per 100 m of net set for 24 hours. Arctic Char CPUE for the August 2000 sampling period was 7.0 char per 100 m of net set for 24 hours. CPUE for 2001 more than doubled that calculated for the downstream portion of the 2000 survey to 5.2 for Lake Trout, 8.0 for Arctic Char and 31.6 for Least Cisco.

Sex Ratios

A close 1:1 ratio between the sexes was observed for Least Cisco (98% sexed) and Arctic Char (85% sexed, with several obviously immature fish released) over both years of the study. Lake Trout sex ratios were biased towards females, although with 25% of the Lake Trout released alive, sex was not determined for several fish. Percent of

females (both years combined) in the sample was; Arctic Char (n=50) 46%, Least Cisco (n=143) 49% and Lake Trout (n=18) 61%.

Water Temperatures

Surface temperatures recorded during the downstream survey in the main portion of the Thomsen were comparable between years with 8°C recorded on July 11 and 10°C recorded on July 17 in both years. The warmest water temperature recorded in 2001 was 11°C in late July while in 2000 the river reached a maximum temperature of 10°C. Temperatures recorded in tributary streams were typically 3-5°C warmer than in the main stem river. Water temperature recorded at Green Cabin on August 15, 2000 was 9°C.

Food Habits

A total of 104 stomachs were collected and examined from three fish species captured during the downstream survey in 2001. Empty stomachs were found in Arctic Char (4 of 15), Lake Trout (4 of 10) and Least Cisco (6 of 79). Although all stomachs were examined in 2000, these were all cursory field examinations and contents were often not identified beyond mammal, fish or invertebrate. Therefore, although the 2000 results appear to have generally been similar to those of 2001, they are not discussed in detail.

Throughout both survey years, stomach contents were highly correlated with insect hatches. Lake Trout and Arctic Char tended to utilise almost any available food source and this opportunistic feeding may reflect an overall paucity of food resources in the river. Prey size was closely related to size of the fish. For example, lemmings and fish were consumed only by the largest Lake Trout. Seasonal shifts in feeding may occur and piscivory, including cannibalism, may be high within some species during some portion of the year. The diets of Arctic Char and Least Cisco were somewhat similar with the exception that cisco ate smaller invertebrate items than did char.

Frequency of occurrence results showed that simulids and chironomids were most important to Least Cisco with both items consumed almost twice as often as amphipods or plecoptera (stoneflies) (Table 2). Arctic Char most frequently consumed plecopertans, tipulid larva (craneflies), and chironomids (in that order). Other items were much less common and the varied diet of char suggests they are the most opportunistic feeders of all. The high percent of char stomachs with debris of some sort likely attests to a benthic feeding habit not seen as often in Lake Trout or Least Cisco. Although the sample was small, Lake Trout tended to concentrate on large prey such as fish and lemmings. A party of tourists encountered on the river mentioned that one of two Lake Trout they had angled had consumed lemmings. Lemmings were eaten by two Lake Trout captured in 2000. Invertebrates consumed by Lake Trout were large, generally very abundant at the time (*i.e.*, tipulids) and consumed in large amounts with high frequency. It is expected that the results presented in Table 2 would vary seasonally and that in areas where conditions for a particular invertebrate prey were ideal, consumption would be higher.

Except for the presence of one marine isopod in a Least Cisco stomach and the possible capture of fish in the Castel Bay estuary by Lake Trout, all items consumed were of freshwater or terrestrial origin. However, as anadromous Arctic Char generally eat little in freshwater when making their way upstream (Johnson 1983), but almost 67% of the char captured in 2001 had consumed food, it is likely that most char captured were

either non-anadromous or in a non-anadromous phase. Anadromous fish (Arctic Char and Least Cisco) may have still been in the marine environment or further out in Castel Bay and not susceptible to capture during the time of the survey.

The Species

Ninespine Stickleback

Ninespine Stickleback were observed in almost all streams tributary to the Thomsen River, but appeared most common in heavily vegetated areas of small (0.5-2.0 m wide) tributaries. Despite seining in several locations, only one stickleback was captured in an open gravel/riffle area of a Thomsen River tributary. One was also captured from an area of broken shale and rubble in the main stem Thomsen River in 2000 approximately 75 km upstream from Castel Bay. Several individuals were collected from disconnected, drying pools along the banks of the Thomsen in 2000. The lack of capture or observation of stickleback from most areas of the Thomsen except in small, vegetated streams and side channels probably explains their absence from the diet of predatory fish.

Baker (1988) noted that several Arctic Char captured in August had eaten Ninespine Stickleback. While the Ninespine Stickleback may be generally thought of as a nutrient cycler, converting invertebrate prey to a higher trophic level, this did not appear to be common in the Thomsen River due to the species' tendency to remain in small streams during the summer. Ninespine Stickleback are probably utilized throughout the summer by species like the Arctic tern (*Sterna paradisaea*) seen feeding at several tributaries. However, when the streams where Ninespine Stickleback are common begin to dry up in the late summer, forced movement out of these streams and into the main stem river may cause them to become a more common and important prey item for Lake Trout and Arctic Char throughout the fall and winter.

Unlike Ninespine Stickleback from some southern areas that possess a reduced pelvic skeleton or no pelvic skeleton at all (*e.g.*, Nelson and Atton 1971), all sticklebacks captured during the survey possessed complete pelvic skeletons. Two of four areas sampled in 2000 possessed individuals in which the modal number of dorsal spines was ten. Of 72 specimens examined from four locations in 2000, 54.2% possessed nine, 41.7% possessed ten, 2.7% possessed eight and 1.4% possessed eleven dorsal spines. Single specimens captured from three other locations possessed nine dorsal spines with the exception of one fish that possessed ten. Of the 44 stickleback from two locations sampled in 2001 (one location different from collection sites of 2000), 45.4% possessed nine, 40.9% possessed ten, 11.4% possessed eight and 2.3% possessed eleven dorsal spines. These results are quite different from those presented by Walters (1955) who suggested a clinal decrease in the number of dorsal spines as latitude decreased.

Table 3 presents the length-frequency distribution for stickleback captured in 2000 and 2001. All sticklebacks weighed and measured were captured between July 14 and 19 in 2000 and July 12 and 15 in 2001. Lengths of Ninespine Stickleback captured in the Thomsen are comparable with the ranges (21-60 mm) of those captured along the southeast Beaufort Sea (Lawrence *et al.* 1984).

The known distribution of Ninespine Stickleback on Banks Island is shown in Figure 2. Due to the infrequent use of seine nets in most previous studies, the distribution of Ninespine Stickleback throughout Banks Island, including the Thomsen River, is

probably greatly underestimated.

Least Cisco

Least Cisco were the most abundant species captured by gill nets in both years of the survey. Due to their wide distribution, Least Cisco must be an important prey item, at least seasonally, to some species. Average age of 50 Least Cisco captured in 2000 was 12 (SD = 2.17; range 7–18). Average age of 70 Least Cisco captured during 2001 was 10 (SD = 1.9; range 6–15). Least Cisco were distributed throughout the entire river and captured at almost every netting location. Length-frequency distribution is presented in Table 4. Least Cisco exhibited unimodal distributions of both age and length. Over 70% of all Least Cisco captured were within a small (50 mm) fork length interval (326-376 mm) representing seven of the thirteen age classes present in the samples.

The average number of scales in the lateral line (mean=78, SD=3.9, range=74-85) enumerated from 18 fish captured in 2000 and 2001 fell within the range (63-94) of those reported from other areas (Scott and Crossman 1973). Similarly, the average number of pyloric caeca (mean=90, SD=10.0, range=80-110) enumerated from twelve fish captured in 2001 fall within the mean of the range (74-111) given for the species (McPhail and Lindsey 1970). Their extreme northern distribution, the shape of the jaw and the lateral line scale and pyloric caeca counts exclude the possibility of these fish being any cisco species other than Least Cisco which further confirms the misidentification of the species as Lake Herring made by Wilkinson *et al.* (1977).

Least Cisco exhibited a relatively constant growth rate until reaching approximately 300 mm in FL. At that length, all cisco were aged at a minimum of eight years although variations in age were present. While some of the length at age differences are likely related to variation in growth rates of males and females, cisco of the same sex also exhibited differences in length at a given age. Least Cisco tended to reach a maximum length at 10 years and exhibited little growth after that time (Table 4). Similar large, long lived Least Cisco have been recorded from a lake on Prince of Wales Island (Stewart and Bernier 1982).

Length at age was greater for Thomsen River Least Cisco than those captured at Liverpool Bay (69°50'N 130°20'W) (Bond and Erickson 1993). Least Cisco with an average length of near 350 mm were between 11-13 years in the Thomsen while closer to 14-15 in the Liverpool Bay area. Both stocks are considered unexploited. Least Cisco captured in the Thomsen River did exhibit a range of ages similar to those reported for Liverpool Bay. However, Least Cisco in the Thomsen River lived longer and grew larger than those from many northern areas (McPhail and Lindsey 1970).

A comparison of length-frequency data for Least Cisco captured in 2000 and 2001 with those captured by Wilkinson *et al.* (1977) in 1977 showed that the length frequency of the stock had not changed appreciably in over 20 years. In 2000 and 2001 79.7% of the Least Cisco fell into the 326-400 FL category. Wilkinson's *et al.* (1977) sample for the same length classes comprised 82.8% of the Least Cisco captured. Not enough weights were reported by Wilkinson *et al.* (1977) to compare condition factor between years.

Mean condition of 67 Least Cisco captured during the entire 2000 survey (June through August) was 0.995. Mean condition factor calculated for 79 Least Cisco captured in 2001 (early to mid July) was 1.130. For 10 mm length intervals, fish from 2001 exhibited much

better condition than those from 2000 (Table 5). A lower condition in 2000 may be due to the capture of fish over a longer and earlier period of time, possibly before food was widely available. While sampling error might be involved, similar low conditions were not calculated for Lake Trout or Arctic Char suggesting sampling error was not the cause. Condition factors for 2000 and 2001 are similar to those reported for populations on King William Island (1.005) and southern Victoria Island (1.043) sampled in early to mid August (Stewart and Bernier 1983) when condition is expected to be higher.

Least Cisco captured in 2001 were classed as 26 pre-spawning and 15 resting males and 18 pre-spawning and 19 resting females. Maturity of one cisco was not recorded. The youngest mature male and female ciscos recorded in both 2000 and 2001 were aged at nine years and were approximately 340 mm in FL. This is similar to findings from Victoria Island (Stewart and Bernier 1983) where Least Cisco were mature at nine years and near 410 mm in FL. Spawning probably takes place in September on both islands.

YOY Least Cisco were captured near the mouth of Able Creek (73°43'N 119°55'W) in 2000 suggesting that they may have been washed downstream, possibly from Shoran Lake where the species has been collected (Sutherland and Golke 1978). The location of any spawning areas remain unknown and as the species' spawns over sand or gravel shallows (Scott and Crossman 1973), spawning grounds could be almost anywhere along the Thomsen and its' tributaries. Bond and Erickson (1985) noted that young Least Cisco migrate into tundra lakes along the Tuktoyaktuk Peninsula where they remain for several years before returning to the coast. There is the possibility that lakes in the Thomsen River flood plain could provide a similar rearing habitat for Least Cisco.

All but one Least Cisco examined internally in 2000 possessed parasites on the stomach. These were tentatively identified as *Diphyllobothrium* spp., also commonly found in Lake Trout and Arctic Char in the Northwest Territories. All stomachs examined in 2001 were noted to have these parasites.

The locations where Least Cisco have been captured on Banks Island are shown in Figure 3.

Lake Trout

Lake Trout were most common in large, deep pools and eddies, although several were captured in water of less than one metre. Average age of six Lake Trout captured and aged in 2000 was 20 (SD = 8.50; range 9–34). Average age of eight Lake Trout captured and aged in 2001 was 16 (SD = 6.84; range 8–25). Lake Trout were most common in mid and lower reaches of the Thomsen (30-80 km upriver from Castel Bay) and only three of the 24 captured in 2000 and 2001 were captured in the Green Cabin area. Because the largest Lake Trout were released (n=6; average FL=831 mm) without any kind of reliable aging tissues being collected, the average and maximum age of the stock is thought to be much higher than reported here.

Similar to Least Cisco, Lake Trout exhibited great variation in age at length although due to the small aged sample this condition was not obvious until the fish attained a length of 650 mm correlating with a minimum age of approximately 15. As an example, within the 650-699 mm length class, five Lake Trout ranged in age from 15 to 25 years (Table 6). In both years of the survey there were only a few small, young fish captured. Although a small sample, some fish in the very young age groups and middle age classes (*e.g.*, <8

and 11-15 years) were never captured. Almost all released fish in both years were of a size that would be unlikely to represent any of these age groups.

Mean condition factor calculated for 13 Lake Trout in 2001 was 0.999 (Table 7). Mean condition of five Lake Trout captured during the downstream portion of the survey in 2000 was 1.017. Including the two Lake Trout captured during August of 2000, mean condition factor was 0.981. These condition factors compare well with those reported for Lake Trout populations on northern Victoria and Stefansson islands (0.904 - 1.208) (Stewart and Bernier 1982).

Of some note was the occurrence of constricted testes observed in a single Lake Trout that was dead sampled in 2000. In 2001 an additional six male Lake Trout were dead sampled and all were found to possess similar constricted testes. Both testes were affected and typical testes had three constrictions on the left and four on the right (Fig. 4). This condition, although with larger constrictions, has been documented in Lake Trout and other salmonids and non-salmonids in the Great Lakes and nearby areas (Fitzsimons and Cairns 2000). Constricted testes were not observed in Arctic Char or Least Cisco captured in the Thomsen River. The cause or effect of such a condition is unknown although it is not believed to interfere with reproduction (Fitzsimons and Cairns 2000). It is thought that this condition has not been previously reported in any fish species from other areas of the Arctic.

Maturity of Lake Trout captured in 2000 was judged as two pre-spawning and one resting male and three pre-spawning and one resting female. In 2001 Lake Trout were classed as three pre-spawning and one resting male. Females were classed as five pre-spawning and one resting. Sample size was too small to estimate when sexual maturity begins.

Johnson (1973) listed the third week of August as the spawning period for Lake Trout in Namaycush Lake (71°30'N 108°00'W) on Victoria Island and Baker (1988) reported ripe females and running males between August 14 and 17 from "West Lake" draining into the Thomsen. Except for this lake, no other area within the Thomsen River watershed has been identified as a spawning area for Lake Trout.

Lake Trout are the longest lived fish species on Banks Island and reach greater sizes than Arctic Char. As the main piscivorous species in the river, at least during the summer months, Lake Trout fill the role of top predator within the system. The distribution of Lake Trout on Banks Island is shown in Figure 5.

Arctic Char

Arctic Char were captured primarily in upstream areas of the Thomsen with few captured in lower reaches. In early July 2001, nine of the 20 Arctic char captured during the survey came from a single net set at Green Cabin and three were captured in the same location the next day. In contrast, only two were captured in Castel Bay. The capture of 25 Arctic Char at Green Cabin over the course of four days in mid August of 2000 suggests that char were moving to upstream spawning or over-wintering areas. Baker (1988), however, did not report any movement of char into "West Lake" in late August.

Average age of 30 Arctic Char captured in 2000 was 8 (SD = 5.01; range 4 – 24) while the average age of 14 Arctic Char captured in 2001 was 10 (SD = 3.80; range 6 – 19)

(Table 8). These maximum ages are similar to those reported by Baker (1988) who captured fish up to 20 years of age in "West Lake", tributary to the Thomsen. The release of several large char captured during this survey suggests that some fish may achieve greater ages than reported here.

Arctic Char exhibited variation in length at age although this was not clearly obvious until fish entered the 450+ mm size class. All 50 mm length classes between 300 and 450 mm possessed fish from only three or four age groups. However, once fish reached 450+ mm, growth was such that there were sometimes fish from 13 different age classes within each 50 mm length class.

Mean condition of 20 Arctic Char captured in 2001 was 1.025 (Table 9). Mean condition of 12 char captured during the downstream portion of the survey in 2000 was 1.003. Mean condition factor of 23 char captured in August 2000 was 0.948. Except for the condition factor calculated for August captured fish, these results are similar to the K of 1.020 calculated for char captured in Baker's (1988) "West Lake" tributary to the Thomsen. Condition factors for Thomsen River Arctic Char were somewhat higher than those calculated for northern Victoria Island (0.914 – 0.943) (Stewart and Bernier 1982).

Examination of strontium levels from eleven Arctic Char captured in 2000 and 2001 showed that there are both anadromous and non-anadromous stocks present in the Thomsen River (Table 10). Anadromous and non-anadromous char were captured in the same net and it was impossible to visually distinguish them. Although a small sample, non-anadromous fish were aged up to 24+ years showing that these results are not just a result of looking at young fish. The oldest anadromous char was aged at 13+ years. Although a small sample size, the results in Table 10 suggest that anadromous char grow faster than non-anadromous fish and that their condition factor may be slightly higher. Others have found similar results (*e.g.*, Radtke *et al.* 1996). Several of the char determined to have an anadromous history also exhibited strontium signatures suggesting complete freshwater years or some estuarine use in some years. While not a full scale ocean visit, this suggests the use of Castel Bay, presumably for feeding.

Stewart and Bernier (1983) stated that Arctic Char on Victoria Island generally mature between 7-11 years at lengths greater than 390 mm. That age and length corresponds well with those found during this survey as no char less than seven years was considered mature. This finding also corresponds well with the first ocean trip by Thomsen River char (aged six).

Pre-spawning Arctic Char comprised three of 13 males and six of 10 females captured during the 2000 downstream survey. Char captured in August were classed as one pre-spawning and nine non-spawning females and 15 non-spawning males. In 2001 there were five pre-spawning and two non-spawning males and two pre-spawning and six non-spawning females. This seems to be evidence enough to state that all fish do not spawn on an annual basis as is true with other Arctic Char stocks (Stewart and Bernier 1982, 1983).

Juvenile and YOY Arctic Char captured in 2000 from two unnamed streams (73°29'N, 120°01'W and 73°38'N, 119°58'W) approximately 60 km upstream from Castel Bay suggest the location of probable spawning areas. Water temperature in both streams was near 16°C; approximately 6°C warmer than the Thomsen River at that time. One lake draining directly into one of these streams was ice covered in mid July suggesting

possible great depth. A second stream was fed by an open lake, but in turn was fed by other lakes not visited. Arctic terns were observed fishing near the mouth of both of these streams and large numbers of YOY char were observed in these areas. These streams almost certainly become too small for continued habitation later in the summer and juvenile and YOY fish may move to the upstream lakes. The large size of several fish (more than twice the length of many of the YOY) may indicate that an over wintering movement takes place into the lakes in the fall.

Large juvenile Arctic Char were also electroshocked in the Thomsen River approximately 75 km upstream from Castel Bay in an area dominated by shale and rubble where small fish had been noted in 2000 and several YOY and juvenile char were captured in 2001. A relatively small char (208 mm FL) captured in Dissection Creek (73°15'N, 119°36'W) (approximately 105 km upstream from Castel Bay) may suggest the possibility of another spawning area somewhere up that creek. Dissection Creek is the longest tributary and has the largest drainage area of tributaries in the lower Thomsen River and therefore has many areas, including several small lakes, where spawning could be possible. A small char (105 mm FL) captured at the mouth of Able Creek also suggests possible spawning in the creek itself or in upstream Shoran Lake. Zoltai *et al.* (1980) identified two areas in the Thomsen River as well as one in the Muskox River and Baker's (1988) "West Lake" as probable Arctic Char spawning areas

The known distribution of Arctic Char throughout Banks Island is shown in Figure 6.

Deepwater and Fourhorn Sculpin

There are no confirmed records of the Deepwater Sculpin (*Myoxocephalus thompsonii*) from the freshwaters of Banks Island in any major Canadian museum although several researchers on Banks Island have reported their capture. The taxonomy of the Deepwater Sculpin (currently recognized as occurring only in freshwater lakes of the mainland) (COSEWIC 2006) and Fourhorn Sculpin (*M. quadricornis*) (found in marine, brackish and freshwater areas of the mainland and Arctic islands) (COSEWIC 2003) has received considerable attention and several changes in nomenclature have been proposed (see Scott and Crossman 1973; Nelson *et al.* 2004). Generally, most researchers now accept the Deepwater Sculpin to be a continental, freshwater form found almost exclusively in large lakes while the Fourhorn Sculpin is primarily a marine species which also exists as a freshwater form. Due to the long history of unsettled taxonomic status, the reports of Deepwater Sculpin, but using the now recognized binomial of the Fourhorn Sculpin (*i.e.*, *Myoxocephalus quadricornis*), from Banks Island are likely more a result of using the then commonly accepted name of a taxonomically complex group of organisms rather than what is now viewed as a species that is considered distinct. Therefore, even when not confirmed by experts, the reported captures of Deepwater Sculpin are considered to have actually been captures of marine Fourhorn Sculpin. That all known captures were reported from brackish water areas, typically in or near Castel Bay, lends additional support to this hypothesis.

Fourhorn Sculpin were captured only in the brackish waters of Castel Bay in 2001. The large size of the individuals (191 and 231 mm total length) and the capture location suggest that they were the marine form. The two largest lakes on Banks Island are the so called "West" and "East" lakes examined by Baker (1988). West Lake drains into the Thomsen River, but it is a shallow, sand bottomed lake (Baker 1988) and may not be suitable for sculpin. East Lake is the largest lake on Banks Island and is deeper than

West Lake. Sculpins have not been captured in either lake (Sutherland and Golke 1978, Baker 1988) nor did they appear in the stomach contents of Arctic Char (Baker 1988).

Considerable time spent seining areas of the main river and seining and electroshocking small streams did not produce any sculpins suggesting they are rare, if indeed they are present at all in these areas. There has been only limited study of a few lakes draining to the Thomsen (*e.g.*, Wilkinson *et al.* 1977, Sutherland and Golke 1978, Baker 1988) and while the freshwater form of the Fourhorn Sculpin may yet be found in some of the larger lakes when properly surveyed with small mesh nets, the presence of them on the island and in the Thomsen River specifically, remains highly improbable. The capture of a Lake Trout in 2001 approximately 60 km upstream of Castel Bay with a sculpin tentatively identified as a Fourhorn Sculpin (approximately 200 mm total length) in its' stomach, may suggest that these sculpin frequent the freshwaters of the river and might be the source of the reports of "Deepwater Sculpin" collected in upstream reaches of other Banks Island rivers. Alternatively, the sculpin could have been consumed in or near Castel Bay before the Lake Trout moved upstream. Figure 7 shows the collection sites of what are now all considered to have been marine Fourhorn Sculpin on Banks Island.

Zoogeography

The Canadian Arctic islands are believed to have been deglaciated approximately 6,000 years ago (Crossman and McAllister 1986) as ice retreated from the southwest to the northeast. Victoria Island undoubtedly provided a stepping stone for some fish moving to Banks Island from the mainland. All fish species found on Banks Island can currently be found in one or more rivers draining into nearby Minto Inlet of western Victoria Island. Most of these species have been captured in rivers and lakes draining to the east coast of Banks Island suggesting a link between the two areas. The Melville Hills of northwest Banks Island, an area never glaciated and suspected of being a glacial refuge (Crossman and McAllister 1986), may have been the source of some species currently found on Banks and, perhaps, Victoria Island. However, the debate as to whether or not this and adjacent areas that remained unglaciated during the Wisconsin glacial maximums were habitable, even by fish, remains unresolved (*e.g.*, Maher 1968, Crossman and McAllister 1986, Briner *et al.* 2003, Harington 2005, MacPhee 2007).

Although all of the species currently present in the Thomsen River possess some salt-water tolerance, under current conditions, none seem capable of surviving a journey directly between the mainland and Banks Island. Marine conditions were undeniably different during colonisation and a larger freshwater surface layer, either from melting glaciers or spring runoff may have enhanced the abilities of fish to disperse to Arctic islands. Travel between islands when a portion of the world's water was still locked up in melting glacial ice and sea levels were lower would have made the journey between shorelines shorter. However, the problem of suitable habitat existing in recently rebounded areas would have come into play. Therefore, factors other than salinity tolerance (*e.g.*, climate, available habitat, prevailing currents) may have initially and may continue to prevent some species from colonising some Arctic islands.

Colonisation of Banks Island by Lake Trout and Lake Whitefish was most probably from the south and east with both species arriving *via* Victoria Island. Lake Trout are known to have some level of anadromous capacity (Walters 1955, Swanson *et al.* 2010) and they may have crossed from Victoria to Banks Island in low salinity sea water during a spring freshet, perhaps also assisted by reduced distances of travel due to lower sea levels.

Dispersal across Banks Islands was then most probably accomplished *via* headwater captures over the island's low topography rather than by coastal movement. Crossman and McAllister (1986) provided evidence for a Mississippi refugium for Lake Trout and Lake Whitefish including morphometric evidence to support their hypothesis that Lake Trout on Victoria Island originated from that area. Wilson and Hebert (1998), however, countered that evidence by providing genetic results which show that Lake Trout on the Arctic islands survived in one of at least two areas in Beringia and closely followed the retreat of the ice sheets to access currently inhabited areas.

Lake Whitefish numbers are generally low wherever the species is encountered on Victoria Island (Stewart and Bernier 1983) and they are confined primarily to the south of that island (Stewart and Bernier 1982). The possibility of Lake Whitefish within the Thomsen watershed remains somewhat speculative as it is based on the capture of a single fish (305 mm FL) that was not preserved or photographed. Although Least Cisco have been reported from the lake where Baker (1988) captured the whitefish (Sutherland and Golke 1978), Baker (1988) did not report capturing any suggesting the possibility that the small whitefish could have been a misidentified Least Cisco. Alternatively, as the number of Lake Whitefish harvested annually from the Sachs River is low (Stephenson 2004) suggesting that there is only a small population in that river, a similarly small population may exist in the Thomsen watershed. Additional netting with small mesh nets in the lake where Baker (1988) reported the capture of the Lake Whitefish may reveal the presence of additional specimens.

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Arctic Char may have survived the last ice advances in the unglaciated area of north western Banks Island (Crossman and McAllister 1986). The absence of the parasite *Cystidicola stigmatura* in Banks Island Arctic Char (Black 1983, Wilson *et al.* 1996) suggests the possible establishment of char populations on Banks Island prior to the arrival of char from the east which possess the parasite, therefore supporting the hypothesis of a Banks Island refugium. Brunner *et al.* (2001) stated that the widespread distribution of a northern haplotype of Arctic Char provided support for the existence of an Arctic island refugium (although no location for this refugium was given). Analysis of tissues collected during this survey and comparison with Arctic Char from other Arctic islands may reveal unique traits and could provide further support for an area refugium.

McPhail and Lindsey (1970) suggested a Beringia refugium for Least Cisco. Assuming it was a suitable refuge, Least Cisco may have also survived glaciation on Banks Islands (Crossman and McAllister 1986), thereby explaining their presence on Banks Island. There is currently not enough data to conclusively state the origin of Banks Island Least Cisco although their wide distribution and presence on Victoria, Prince of Wales and King William islands may suggest an advance from Beringia with a gradual colonization of near shore Arctic Islands across low saline waters rather than colonization of those areas from an as yet unproven refugium on Banks Island. More work detailing the distribution of this species on the Arctic islands is required and a genetic study, including samples from the Thomsen River, could help determine the origin of these populations.

Why the Arctic Cisco, a coregonid with a great saline tolerance, has not yet reached Banks Island remains a mystery. Arctic Cisco on Victoria Island are found primarily on the southern and central part of the island which may mark the location of first arrival. Arctic Cisco are thought to have survived the last glaciation in unglaciated coastal areas of Alaska (Crossman and McAllister 1986). The most likely explanation for their absence from Banks Island is that the initial distance from and speed at which they dispersed

towards Victoria Island was such that by the time they arrived in the area, isostatic rebound and distance prevented widespread dispersal throughout the area. Likely enough time has elapsed for the species to find their way to Banks Island and the species may yet appear, but prevailing currents and temperatures in Prince of Wales Strait may be acting as barriers halting their movement to Banks Island. Since rivers on the eastern side of Banks Island are generally short, they may not provide the habitat required for the species to establish an initial population before becoming more widespread and being able to colonise larger rivers on the island, such as the Thomsen.

Fourhorn Sculpin are believed to have survived the last glaciation in the Arctic Ocean north of the Bering land bridge and thereafter made the transition to freshwater as their marine habitats were isolated through the process of isostatic rebound (Crossman and McAllister 1986). Their presence, almost exclusively in large lakes on islands such as Melville, Victoria and Bathurst (COSEWIC 2003), shows that Fourhorn Sculpin became trapped in multiple areas and that those populations slowly adapted to freshwater as the future lakes became less saline. The geology of Banks Island is such that very few large lakes were formed within the low, rolling hills which form the majority of the island's landscape. Lake formation didn't occur as frequently on Banks as on other islands because much or the island was unglaciated during the last glacial maximum (Dyke and Prest 1987, Gajewski *et al.* 2000) so that the conditions required to produce lakes (*i.e.*, glacially scoured areas and isostatic rebound) were largely absent. Additional study with small mesh nets concentrating on the few, large lakes on the island, would be necessary to confirm the presence of the freshwater form.

Walters (1955) imagined Ninespine Stickleback surviving in multiple refugia with a mixing of stocks following deglaciation. Crossman and McAllister (1986) suggested that Ninespine Stickleback may have survived in a Bering refugium prior to their dispersal throughout the Arctic islands. Although fish from Banks Island were not included in the study, recent genetic work (Aldenhoven *et al.* 2010) has confirmed a Bering origin for most Canadian Arctic Ninespine Stickleback. Additional genetic study may shed more light on the origins of Banks Island sticklebacks. Due to the wide environmental conditions they tolerate and the varied habitats in which they can be found, Ninespine Stickleback represent a species that may have existed in a Banks Island refuge, even one with extremely harsh conditions.

CONCLUSIONS AND AREAS FOR FURTHER STUDY

Figure 8 shows the capture location of all species captured in 2000 and 2001 and also identifies possible Arctic Char spawning areas. Table 11 presents similar information, but in greater detail.

Since the earliest studies and surveys on the Thomsen River the fisheries priorities have remained the same; identification of species present, determining the life history characteristics of these species, identification of spawning areas and other critical habitats, and determining safe harvest levels. From this and previous studies, only portions of these priority questions have been answered. It appears unlikely that additional species remain to be found in the Thomsen watershed and therefore it seems probable that the Thomsen River is home to, at best, six fish species, all of which remain rather poorly understood with regards to distribution, degree of anadromy and location of critical habitats. The presence of Lake Whitefish in the Thomsen River watershed

remains somewhat questionable, although because it is known from the south of the island, it may be present in low numbers. Due to a variable and changing taxonomy, records of the Deepwater Sculpin, as we know it today, almost certainly represent intrusions of the marine Fourhorn Sculpin into some brackish water areas. It is probable that the Deepwater Sculpin does not occur anywhere on Banks Island and that Fourhorn Sculpin are transient visitors. Thus it would seem that the Thomsen River is actually home to five species, four of them common (Arctic Char, Lake Trout, Least Cisco and Ninespine Stickleback) with the possibility of Lake Whitefish being a rare species.

Numerous disconnected side channels and pools were observed along the Thomsen and the Muskox rivers in both years of the survey. At times, Ninespine Stickleback and adult Least Cisco were observed and captured within these pools. The stranding of these fish attests to the rapid drop in water level following the spring freshet noted by others (Anderson and Durrant 1976, Wilkinson *et al.* 1977). This rapid drop in water levels also suggests that by late July or early August, many fish may be confined to pools or large areas of the main river in which they must over winter. Accordingly, anadromous fish must migrate upstream at the proper time or risk being barred access from their spawning or over wintering areas. Wilkinson *et al.* (1977) suggested that fragmentation of small rivers meant that movement into many small lakes outside the Thomsen River flood plain was probably impossible for fall migrating fish. Therefore, it is possible that only those lakes in the Thomsen River flood plain or those which have a permanent outflow harbour populations of anadromous fish. Understanding the use and possible importance of flood plain lakes to multiple species should be one priority of future research.

Assuming that the Arctic Char captured by Baker (1988) were all anadromous and that those mature fish captured at Green Cabin in August 2000 were going to spawn in similar upstream areas, spawning migrations from the coast to these locations are close to or may exceed 150 km. The advantages of anadromy (*e.g.*, greater food intake and faster growth) could in this case be outweighed by the costs (*i.e.*, the extreme energy required for migration). Much more energy and time must be expended by Thomsen River char to reach some spawning areas compared to Arctic Char stocks near Paulatuk (Hornaday River) or Ulukhaktok (Kuujjua River) that may migrate only several dozen kilometres to spawn. An upstream spawning migration of 150 km, if it occurs in one year, would make that portion of the Thomsen River Arctic Char one of the longest migrating stocks in the Canadian Arctic. Additional study of anadromous Thomsen River char may show that the price for these migrations is a reduced number of eggs or extended "resting" periods when compared to char from areas with shorter migration distances.

Similar to findings from other Arctic islands (Stewart and Bernier 1982, 1983, 1984), most Thomsen River fish do not reproduce on an annual basis. The capture of Lake Trout, Least Cisco and Arctic Char of similar size, but in either maturing or resting states attests to this. No examination of maturity in Ninespine Stickleback was carried out, but due to their short life span annual reproduction is probable once maturity is reached after their first or second year (Scott and Crossman 1973).

Without extensive mark/recapture programs or the construction of counting weirs during the low water period of summer and fall, it is difficult to estimate the stock size of Arctic Char or Lake Trout within the Thomsen and recommend safe harvest levels. Baker (1988) suggested that sports fishing on "West Lake" would not be feasible due to a short season and the high costs associated with accessing the area although the Lake Trout

population appeared to be quite large. Wilkinson *et al.* (1977) noted that large fish were generally rare making it unlikely that the Thomsen would ever become a sports fishing destination. In addition, Wilkinson *et al.* (1977) noted that once a large Lake Trout was netted from a pool of the river continued netting over several days did not produce any more large fish. Similar observations were made in 2000 and 2001 supporting a theory of territorial behaviour by a few large Lake Trout. The number of large Arctic Char does not appear to be particularly great and as August 2000 netting showed, large harvests could be made during the upstream spawning runs. Least Cisco harvests could perhaps be maintained at moderate levels for a short period while netting, although these numbers would be low relative to the number of fish available in more southern areas. The slow growth by all species compared to more southern stocks or species also argues against any large scale harvesting. The doubling of CPUE from 2000 to 2001, while no doubt reflecting some response from utilising only index nets in 2001, is probably more a result of improved knowledge of the river and illustrates how subsistence or commercial fishing could quickly locate and deplete fish stocks.

The Thomsen River does not possess the fishery resource necessary to sustain long-term commercial or subsistence harvesting. The distance of the Thomsen River from Sachs Harbour and the added distance and cost of shipping fish to outside markets would be prohibitive for any commercial venture. Similarly, subsistence fishing in the Thomsen seems unnecessary when similar if not better fishing opportunities exist closer to the community of Sachs Harbour. The Thomsen River is not in itself an angling destination as better fishing (*i.e.*, higher CPUE as well as more and larger fish) at more prestigious locations can be had closer to and much less expensively in areas to the south. Those that do make the trip to canoe or kayak the Thomsen are generally not intent on catching and retaining large numbers of fish so a relatively high quality angling experience can be supported, but only through low catch and possession limits.

The large size and old age of many fish, the isolated location of the Thomsen River and the very limited fishing pressure suggests that fish stocks of the Thomsen River have adapted to low mortality through natural causes. With the exception of Arctic terns preying on small fish, all other fishing birds capable of catching even sub-adult fish are absent due to a lack of suitable nesting habitat. Thus the removal of large individuals is, with the exception of the occasional angled fish, due exclusively to natural causes.

Similar to the "climax" theory described by Johnson (1976, 1983), large fish, especially Lake Trout, probably control the entry of their own species into the adult population in the Thomsen River. Cannibalism and opportunistic feeding on large prey items as well as living in optimal habitats, may promote the growth of a few large fish while keeping the small fish numbers low or forcing them to remain in sub-optimal habitats. Johnson (1983) also stated that with a limited number of fish species in arctic lakes, it might be possible that the once dominant species would not necessarily re-establish its' role of dominance if reduced in numbers. Arctic Char are thought to be more capable than Lake Trout of rebounding after declines (Johnson 1976). Therefore, within a complex system such as the Thomsen River, a once subordinate species could become dominant, at least temporarily (although the length of "temporarily" could reach into the tens of years) if the current community structure was disrupted. Therefore, to maintain current community structure, protection of Lake Trout is likely of greatest importance within the Thomsen River due to their long life and slow growth. This means not only limiting harvest, but also identifying and protecting spawning habitats.

While the Thomsen River area receives few visitors annually and all depart prior to the fall spawning period of most species, confirmation of suspected spawning areas would prove valuable to safeguard these locations from any possible disturbances (Zoltai *et al.* 1980). While one Lake Trout spawning area is known [*e.g.*, a lake studied by Baker (1988)] and some idea of Arctic Char spawning areas are known, no information is available on where Least Cisco may spawn. Lake Trout spawn in rivers under some conditions (Loftus 1958) and many areas of the Thomsen River 30 - 80 km upstream of Castel Bay possess the pools and gravel substrates which appear to be suitable for spawning. It does not seem plausible that Lake Trout found in these pools in the summer would migrate to distant lakes for spawning. Several lakes identified in the Thomsen River flood plain which appear to be used by Arctic Char clearly lack the access required by Lake Trout, so it is most probable that river spawning by Lake Trout occurs in the river in several locations.

Based on previous survey work and the capture of small char in several streams, several lakes in the Thomsen River flood plain provide spawning and rearing habitat for Arctic Char and Ninespine Stickleback. It also appears that some portion of Dissection Creek may provide, if not spawning habitat, at least rearing habitat for Arctic Char. These locations should be added to those presented by Zoltai *et al.* (1980) (Fig. 8) and classified as critical habitat. Although some preliminary survey work has been carried out on two of the larger lakes in the area (Baker 1988) as well as some cursory work on a few smaller ones (Wilkinson *et al.* 1977, Sutherland and Golke 1978), little information is available on the distribution of fish within most lakes in the park. Survey work in some of the larger lakes of the watershed could perhaps confirm the presence of Lake Whitefish and the possible, but unlikely, presence of freshwater Fourhorn Sculpin.

Although there are no current developmental plans for Banks Island, oil and gas exploration has taken place within the current park boundaries in the past (Stephenson and Hartwig 2010) and may again, especially as a warming climate increases the length of the exploration season. Diamond exploration is now common in the Northwest Territories and could potentially take place in lands outside the park. As almost one-half of the Thomsen watershed lies outside the boundaries of Aulavik National Park (including the largest lake tributary to the Thomsen River), activities within these outlying areas could have a negative impact on fisheries within the park.

Additional surveys could answer more of the priority questions (*e.g.*, species life histories, identification of critical habitats) about the fish of the Thomsen River and information gained from these studies could be used for management and to support or compare hypotheses about southern fish stocks. Fish collection and surveys could provide additional details on critical habitats and overall distribution, especially within the many poorly studied, and potentially important, small lakes on the flood plain and the upstream areas of the river outside the park. Genetic work comparing fish from Banks Island and other areas might resolve the question of a glacial refugium on Banks Island and provide a clearer understanding of the recolonization process on nearby islands. Specific attention given to collecting specimens from within or near the unglaciated part of the island would provide the best samples for comparative genetic work. However, the high costs of doing research in the area, the limited length of the field season and the overall low priority of working in this particular area suggest that additional survey work will not be completed in the near future. Until such time as more work can be done in the area, this study will serve as providing additional baseline information on fishes inhabiting the Thomsen River and further compliments the work of previous surveys.

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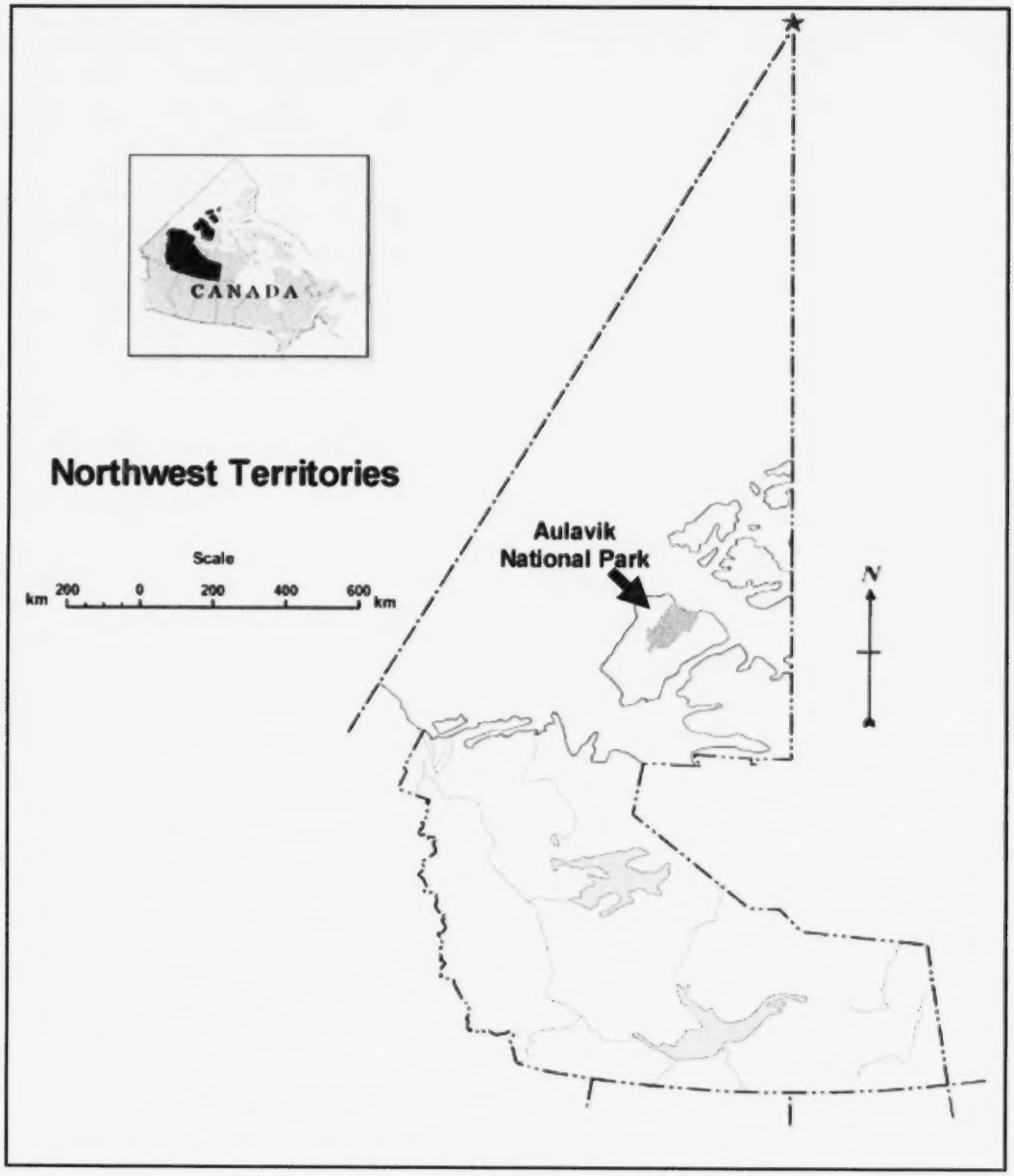

Figure 1: Map of the Northwest Territories showing the location of Aulavik National Park on Banks Island.

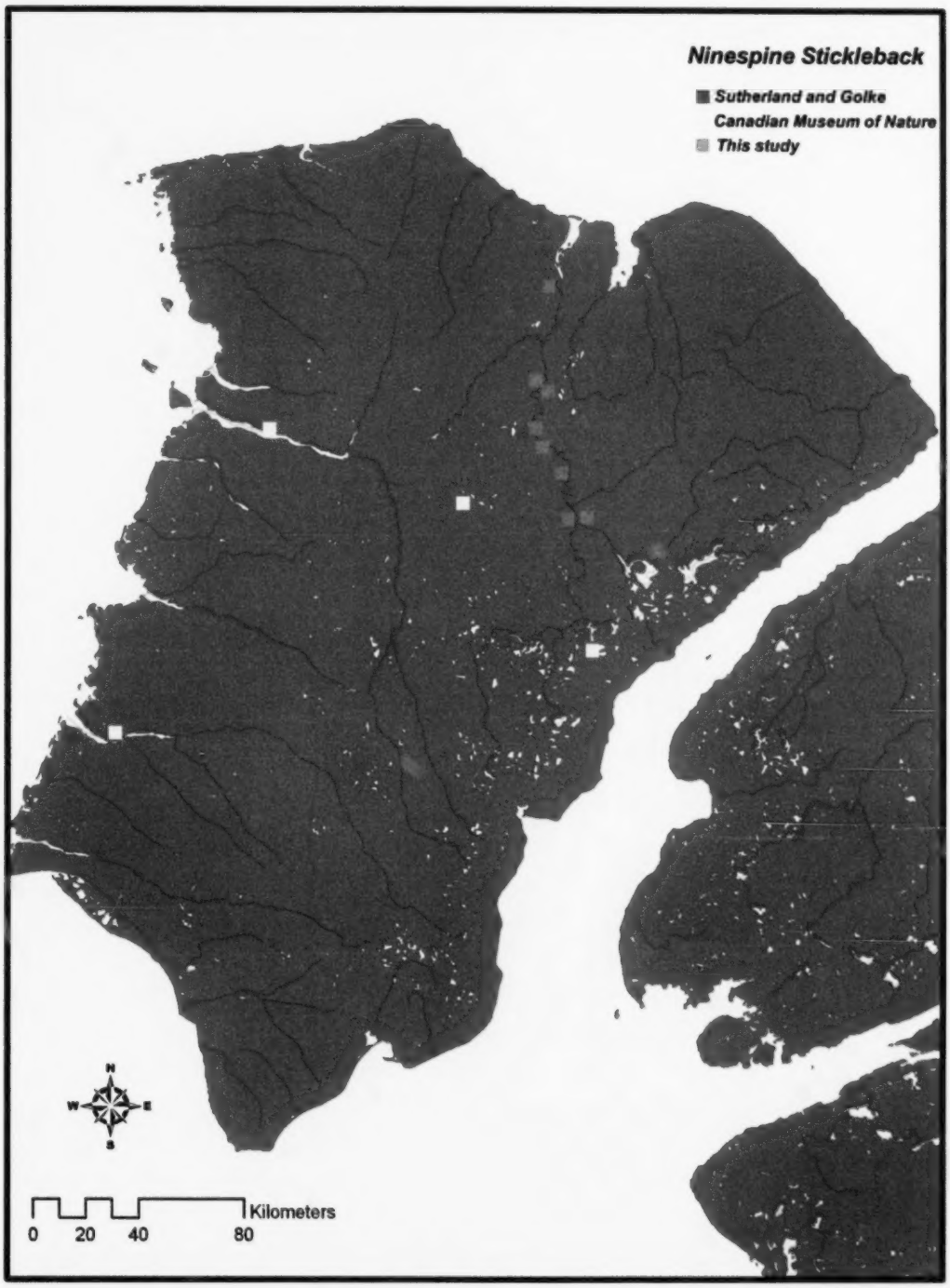

Figure 2: Confirmed and reported distribution of Ninespine Stickleback (*Pungitius pungitius*) based on historic surveys on Banks Island. When confirmed specimens exist in the Canadian Museum of Nature, they are shown instead of field records.

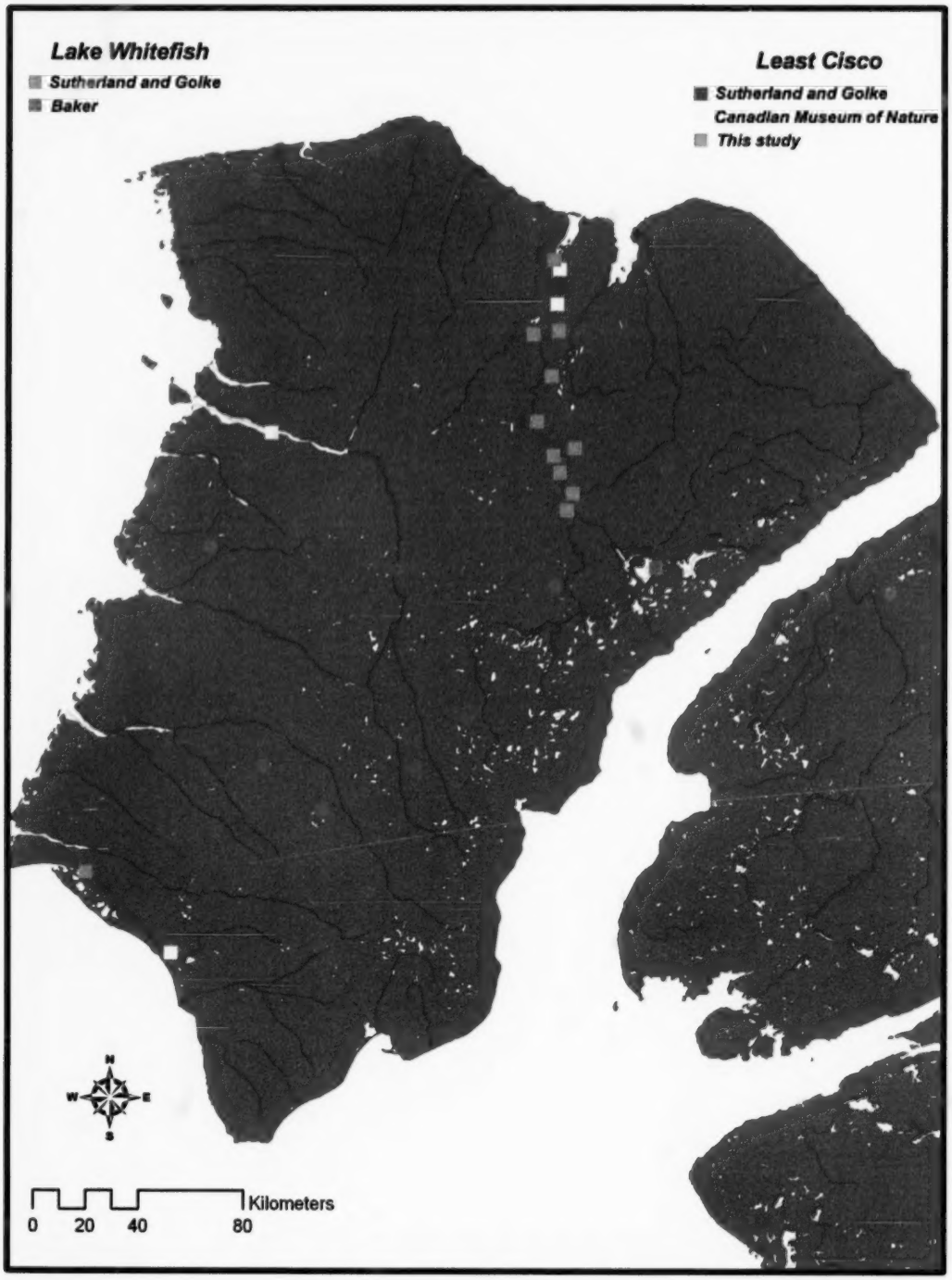

Figure 3: Confirmed and reported distribution of Least Cisco (*Coregonus sardinella*) and Lake Whitefish (*C. clupeaformis*) based on historic surveys on Banks Island. When confirmed specimens exist in the Canadian Museum of Nature, they are shown instead of field records.

Figure 4: Photograph showing typical condition of constricted testes in Thomsen River Lake Trout (660 mm FL; July 10, 2001).

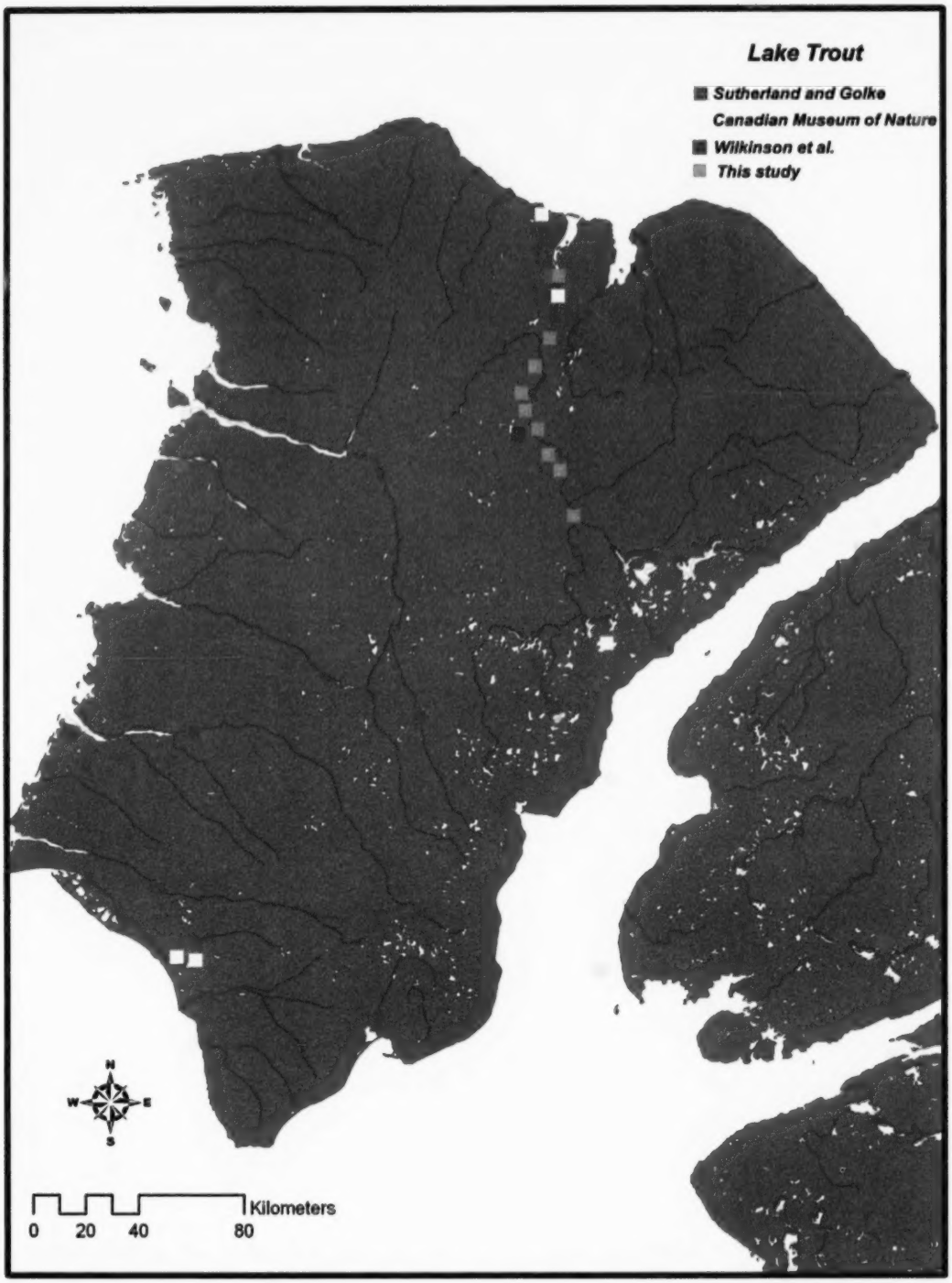

Figure 5: Confirmed and reported distribution of Lake Trout (*Salvelinus namaycush*) based on historic surveys on Banks Island. When confirmed specimens exist in the Canadian Museum of Nature, they are shown instead of field records.

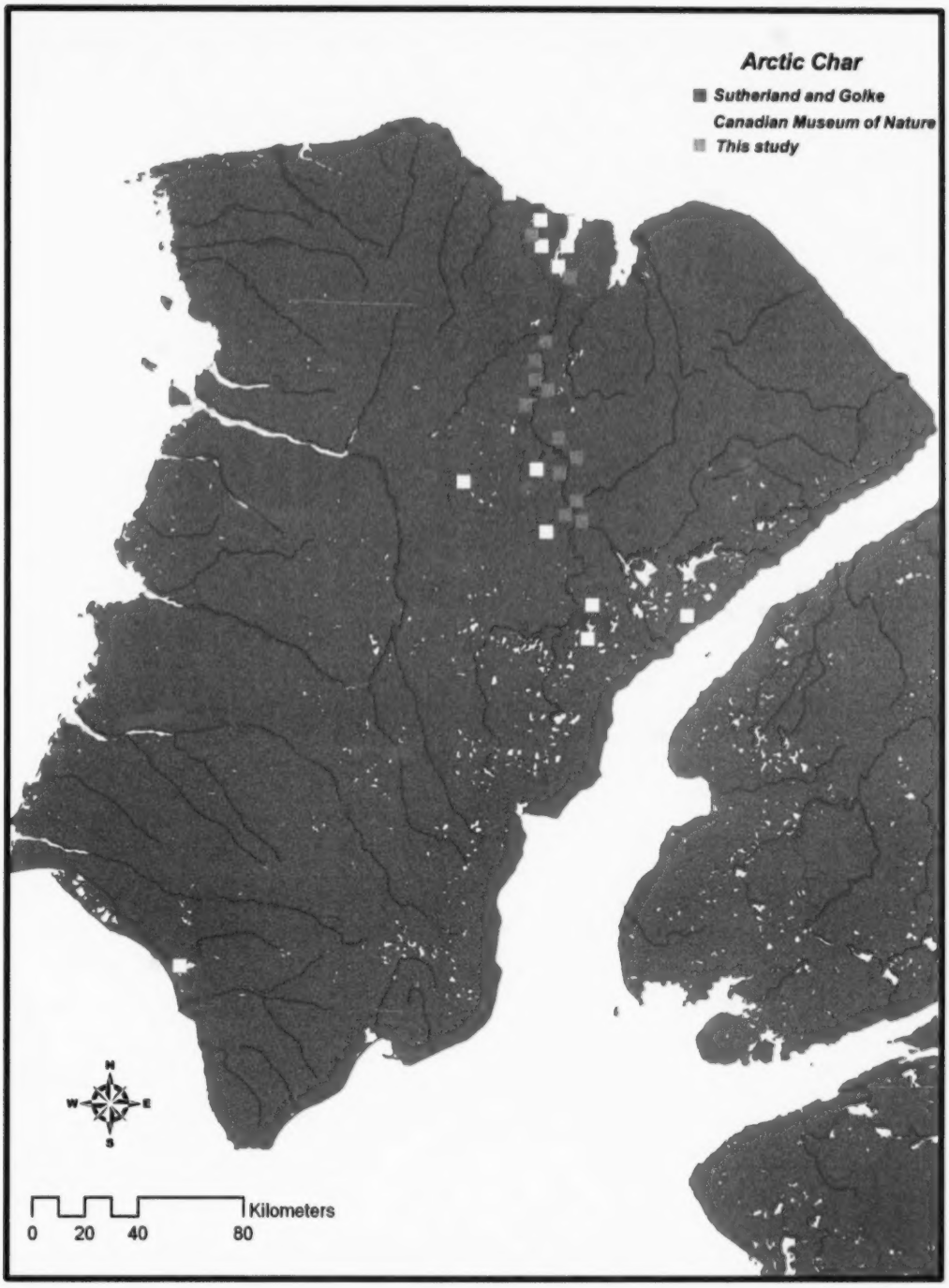

Figure 6: Confirmed and reported distribution of Arctic Char (*Salvelinus alpinus*) based on historic surveys on Banks Island. When confirmed specimens exist in the Canadian Museum of Nature, they are shown instead of field records.

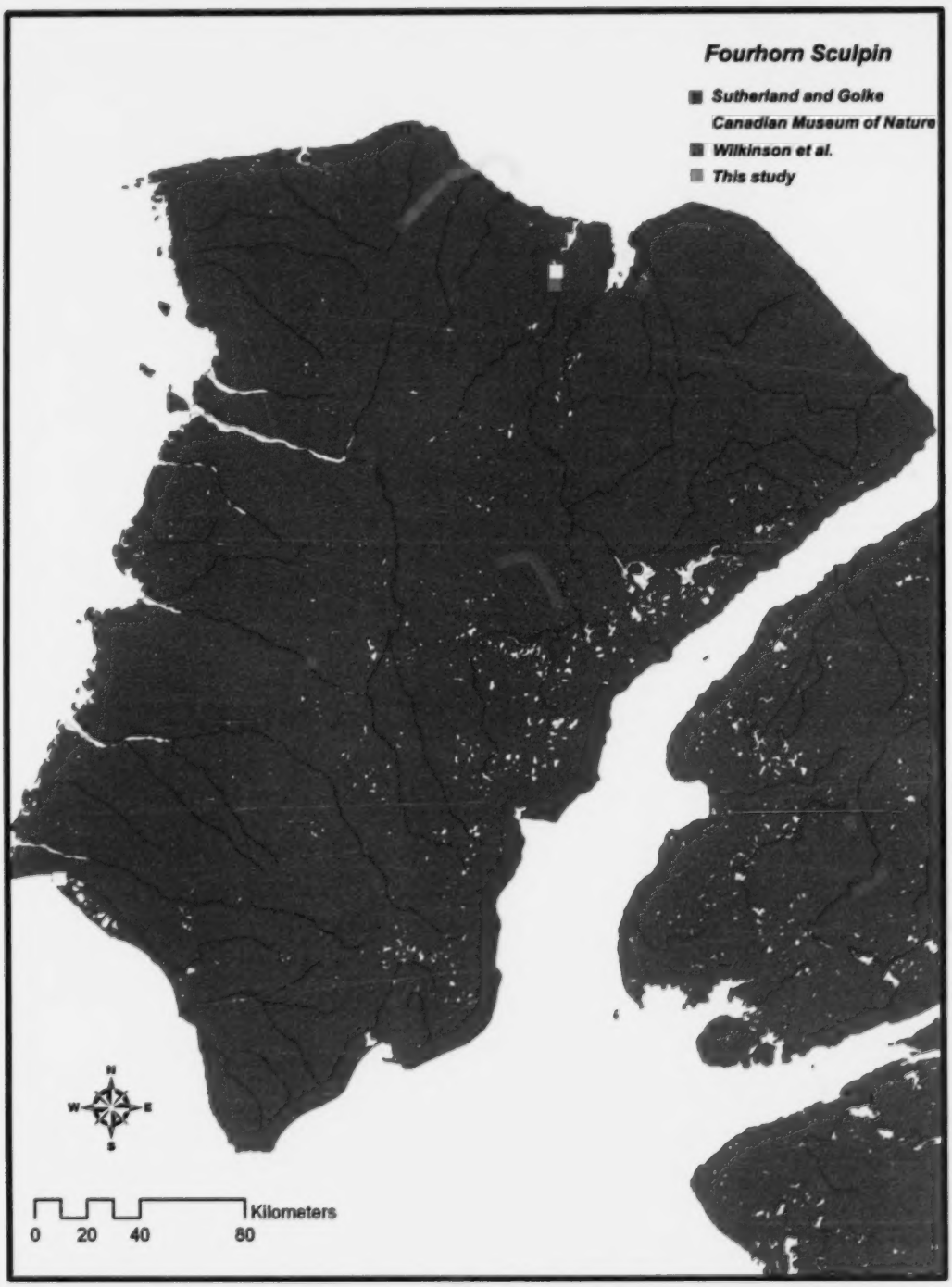

Figure 7: Confirmed and reported distribution of Fourhorn Sculpin (*Myoxocephalus quadricornis*) based on historic surveys on Banks Island. When confirmed specimens exist in the Canadian Museum of Nature, they are shown instead of field records.

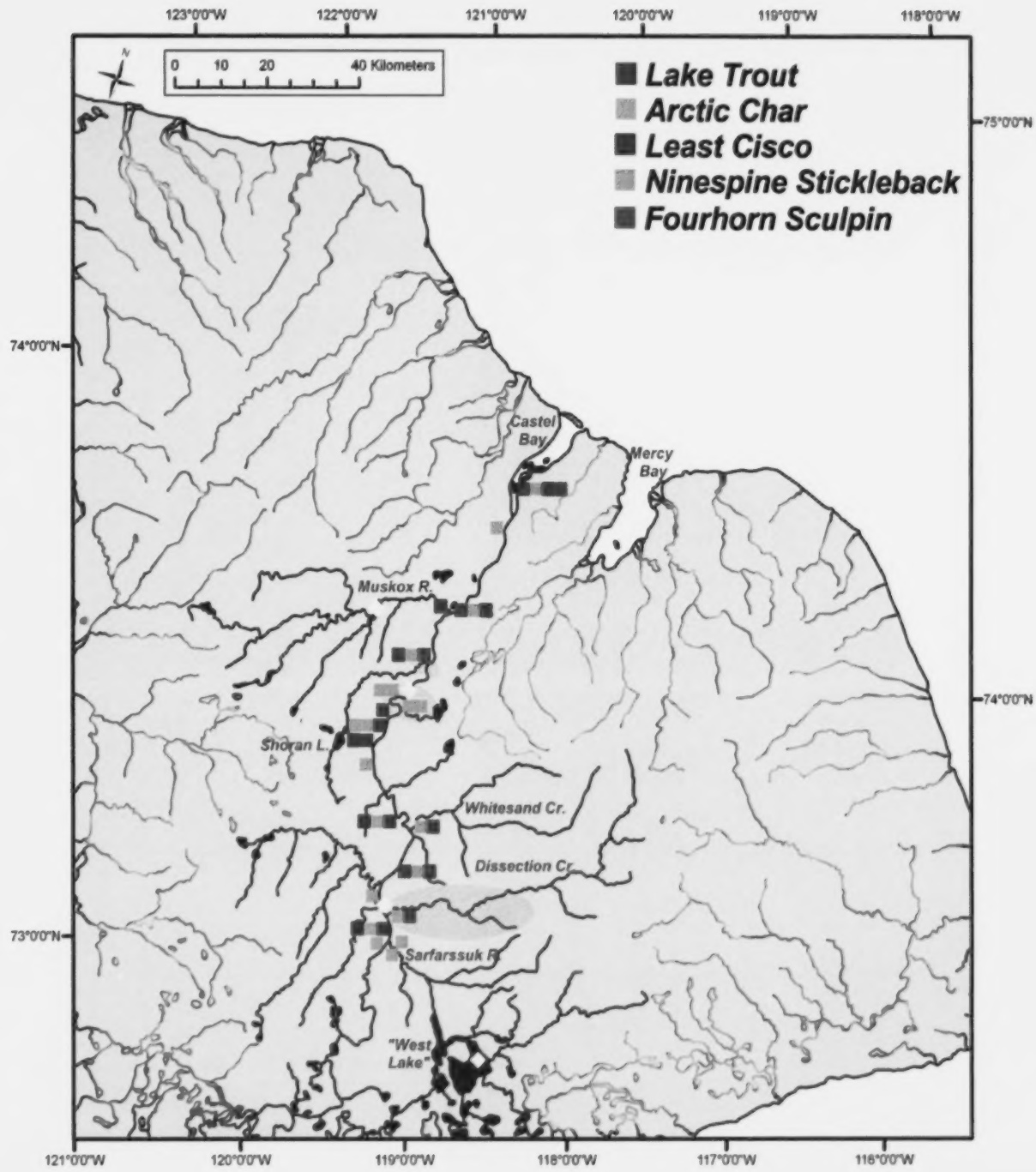

Figure 8: Location of fish species captured during the downstream portions of the 2000 and 2001 survey. Probable Arctic Char spawning areas identified during this study are marked by the ellipses. Probable Arctic Char spawning areas identified by Zoltai *et al.* (1980) are indicated by the yellow diamonds.

Table 1: Summary of fish species captured during previous surveys in the Thomsen River watershed and Castel Bay.

Species captured	Year of study				
	1952	1962	1976	1977	1987
Arctic Char	X	X	X	X	X
Lake Trout	X[A]	X	X	X	X
Lake Whitefish	-	-	-	-	X[B]
Least Cisco	X[A]	X	X	-	-
Lake Herring	-	-	-	X[A]	-
Ninespine Stickleback	-	-	X	-	X[C]
Sculpin spp.	X[D]	X[E]	-	X[A, F]	-

Reference:
1952 – Manning (1953a)
1962 – Hunter (1963)
1976 – Sutherland and Golke (1978)
1977 – Wilkinson *et al.* (1977)
1987 – Baker (1988)

[A] Captured only in Castel Bay
[B] Single specimen not preserved
[C] Reported only as stomach contents
[D] Captured only in Castel Bay and listed simply as "sculpin"
[E] Location given as "Thomsen River" and reported as a cross between *Myoxocephalus quadricornis* and *M. thompsonii*. Note: All listed by the Canadian Museum of Nature as *M. quadricornis* (CMNFI 62-0376.1, 62-0455.1, 62-0460.1, 62-0488.1 and 62-0492.1). Location of capture (74°03'N, 199°43'W or further north) denotes waters of Castel Bay, not the Thomsen River.
[F] Reported as Deepwater Sculpin

Table 2: Percent frequency of occurrence of items found in the stomachs of Arctic Char, Lake Trout and Least Cisco containing food from the Thomsen River, Banks Island, 2001.

Food Item	Arctic Char	Lake Trout	Least Cisco
Lemming spp.	0	33	0
Fish spp.*	0	50	0
Ephemeroptera	18	17	23
Plecoptera	100	33	40
Simulidae	18	17	79
Chironomidae	82	0	63
Amphipoda	0	0	51
Tipulidae	91	50	23
Coleoptera	45	17	3
Arachnid	45	0	6
Hydracarina	9	0	11
Trichoptera	0	0	5
Isopoda	0	0	1
Terrestrial insects	9	0	8
Debris (rocks/leaves)	36	17	7
Number of stomachs with food	**11**	**6**	**73**
Total number of stomachs examined	**15**	**10**	**79**

* Includes Least Cisco, Lake Trout and sculpin spp.

Table 3: Summary of length-frequency distribution for Ninespine Stickleback captured in 2000 and 2001.

Length interval (mm)		11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70
2000	n=75	-	6	33	26	10	-
	%	-	8.0	44.0	34.7	13.3	-
	%	4.6	13.6	38.6	34.1	6.8	2.3
2001	n=44	2	6	17	15	3	1

Table 4: Summary of number aged, range and mean fork length (FL) (mm) by age class, sexes combined, of Thomsen River Least Cisco (2000-2001).

	Age	6	7	8	9	10	11	12	13	14	15	16	17	18
2000	**Number**	-	2	-	4	7	11	12	7	2	2	1	1	1
	Mean FL (mm)	-	243	-	340	339	355	345	349	388	368	374	397	384
	n = 50													
2001	**Number**	2	4	3	8	15	23	6	4	2	3	-	-	-
	Mean FL (mm)	263	279	304	344	344	345	359	352	366	403	-	-	-
	n = 70													
	Total Number	2	6	3	12	22	34	18	11	4	5	1	1	1
	Total Mean FL	263	267	304	343	342	348	349	350	377	389	374	397	384
	Total FL Range	256	238	296	303	325	314	328	323	350	350	-	-	-
		270	289	308	368	371	417	393	387	401	433	-	-	-
	SD	9.89	20.31	6.66	17.85	12.38	18.13	15.36	19.43	21.08	30.78	-	-	-

Table 5: Number, percent of catch, fork length and weight data and condition factor (K), by 10 mm fork length intervals, sexes combined, of Least Cisco caught in 2000 and 2001.

2000					
Length Interval (mm)	n	%	Mean Length (mm)	Mean Weight (g)	K
230	1	1.5	238	130	0.964
240	1	1.5	247	128	0.849
250	1	1.5	257	180	1.060
260	-	-	-	-	-
270	-	-	-	-	-
280	-	-	-	-	-
290	-	-	-	-	-
300	1	1.5	302	250	0.907
310	1	1.5	316	300	0.951
320	4	6.0	326	344	0.993
330	13	19.4	335	390	1.037
340	14	20.8	344	398	0.978
350	15	22.4	354	442	0.996
360	6	8.9	364	480	0.995
370	2	3.0	375	475	0.901
380	3	4.5	383	550	0.979
390	1	1.5	397	700	1.118
400	1	1.5	401	500	0.775
410	2	3.0	414	699	0.981
420	-	-	-	-	-
430	-	-	-	-	-
440	1	1.5	446	1075	1.212
Total	67	100			

2001					
Length Interval (mm)	n	%	Mean Length (mm)	Mean Weight (g)	K
230	-	-	-	-	-
240	-	-	-	-	-
250	1	1.3	256	155	0.923
260	1	1.3	268	225	1.169
270	3	3.8	273	193	0.948
280	3	3.8	284	222	0.969
290	1	1.3	296	250	0.964
300	4	5.0	305	329	1.159
310	1	1.3	314	370	1.195
320	5	6.3	327	426	1.218
330	8	10.0	334	412	1.106
340	19	24.2	343	474	1.174
350	14	17.7	354	495	1.116
360	8	10.0	363	553	1.156
370	3	3.8	374	600	1.147
380	3	3.8	383	616	1.096
390	2	2.5	394	725	1.185
400	1	1.3	400	675	1.055
410	1	1.3	412	725	1.037
420	-	-	-	-	-
430	1	1.3	433	900	1.087
440	-	-	-	-	-
Total	79	100			

Table 6: Summary of number aged, range and mean fork length (FL) (mm) by age class, sexes combined, of Thomsen River Lake Trout (2000-2001).

	Age	8	9	10	-	16	17	18	19	-	21	-	24	25	-	34
2000	Number	-	1	-	-	1	-	1	-	-	1	-	-	1	-	1
	Mean FL (mm)	-	508	-	-	668	-	750	-	-	619	-	-	807	-	847
	n = 6															
2001	Number	2	-	1	-	-	1	-	2	-	-	-	1	1	-	-
	Mean FL (mm)	421	-	455	-	-	660	-	718	-	-	-	715	692	-	-
	n = 8															
	Total Number	2	1	1	-	1	1	1	2	-	1	-	1	2	-	1
	Total Mean FL	421	508	455	-	668	660	750	718	-	619	-	715	750	-	847
	Total FL Range	406	-	-	-	-	-	-	655	-	-	-	-	692	-	-
		436	-	-	-	-	-	-	781	-	-	-	-	807	-	-
	SD	21.21	-	-	-	-	-	-	89.09	-	-	-	-	81.32	-	-

Table 7: Number, percent of catch, length and weight data and condition factor (K), by 10 mm fork length intervals, sexes combined, of Lake Trout caught in 2000 and 2001. Weights indicated by a "+" were estimated from girth and length.

2000					
Length Interval (mm)	n	%	Mean Length (mm)	Mean Weight (g)	K
400	-	-	-	-	-
410	-	-	-	-	-
420	-	-	-	-	-
430	-	-	-	-	-
440	-	-	-	-	-
450	-	-	-	-	-
-					
500	1	10	508	1300	0.992
-					
600	-	-	-	-	-
610	1	10	619	2250	0.949
620	-	-	-	-	-
630	-	-	-	-	-
640	-	-	-	-	-
650	1	10	655	3100	1.103
660	1	10	668	3000	1.006
670	-	-	-	-	-
680	-	-	-	-	-
690	-	-	-	-	-
700	-	-	-	-	-
710	-	-	-	-	-
720	-	-	-	-	-
730	-	-	-	-	-
740	-	-	-	-	-
750	1	10	750	4100	0.972
760	-	-	-	-	-
770	-	-	-	-	-
780	-	-	-	-	-
790	-	-	-	-	-
800	1	10	807	5400	1.027
810	-	-	-	-	-
820	-	-	-	-	-
830	-	-	-	-	-
840	1	10	847	6480+	1.066
850	-	-	-	-	-
860	-	-	-	-	-
870	-	-	-	-	-
880	1	10	883	6160+	0.895
890	-	-	-	-	-
900	-	-	-	-	-
910	1	10	915	8260+	1.078
920	-	-	-	-	-
930	1	10	930	5800+	0.721
940	-	-	-	-	-
Total	10*	100			

2001					
Length Interval (mm)	n	%	Mean Length (mm)	Mean Weight (g)	K
400	1	7.7	406	625	0.934
410	-	-	-	-	-
420	-	-	-	-	-
430	1	7.7	436	850	1.025
440	-	-	-	-	-
450	1	7.7	455	925	0.982
-					
500	-	-	-	-	-
-					
600	1	7.7	-	-	-
610	-	-	-	-	-
620	-	-	-	-	-
630	-	-	-	-	-
640	-	-	-	-	-
650	1	7.7	655	3000	1.067
660	1	7.7	660	3150	1.095
670	-	-	-	-	-
680	-	-	-	-	-
690	1	7.7	692	3100	0.935
700	-	-	-	-	-
710	1	7.7	715	3700	1.012
720	3	23	726	3733	0.975
730	-	-	-	-	-
740	-	-	-	-	-
750	-	-	-	-	-
760	-	-	-	-	-
770	-	-	-	-	-
780	1	7.7	781	5000	1.049
790	-	-	-	-	-
800	-	-	-	-	-
810	-	-	-	-	-
820	-	-	-	-	-
830	-	-	-	-	-
840	-	-	-	-	-
850	-	-	-	-	-
860	1	7.7	869	7400+	1.127
870	-	-	-	-	-
880	-	-	-	-	-
890	-	-	-	-	-
900	-	-	-	-	-
910	-	-	-	-	-
920	-	-	-	-	-
930	-	-	-	-	-
940	1	7.7	942	7100+	0.849
Total	13	100			

* One fish captured in 2000 did not have lengths recorded.

Table 8: Summary of number aged, range and mean fork length (FL) (mm) by age class, sexes combined, of Thomsen River Arctic Char (2000-2001).

	Age	4	5	6	7	8	10	11	12	13	17	19	23	24
2000	Number	4	4	5	7	1	4	1	1	-	1	-	1	1
	Mean FL (mm)	284	326	384	417	432	501	515	590	-	600	-	585	623
	n = 30													
2001	Number	-	-	3	1	2	1	-	2	4	-	1	-	-
	Mean FL (mm)	-	-	355	366	417	497	-	644	535	-	485	-	-
	n = 14													
	Total Number	4	4	8	8	3	5	1	3	4	1	1	1	1
	Total Mean FL	284	326	373	411	422	500	547	626	535	600	485	585	623
	Total FL Range	208	305	325	366	407	443	-	590	-	-	-	-	-
		364	367	405	460	432	553	-	645	-	-	-	-	-
	SD	73.99	28.36	30.26	35.32	13.23	44.10	-	30.92	-	-	-	-	-

Table 9: Number, percent of catch, length and weight data and condition factor (K), by 10 mm fork length intervals, sexes combined, of Arctic Char caught in 2000 and 2001.

2000 Length Interval (mm)	n	%	Mean Length (mm)	Mean Weight (g)	K
200	1	2.7	208	80	0.889
210	-	-	-	-	-
220	-	-	-	-	-
230	1	2.7	235	110	0.847
-					
300	1	2.7	305	230	0.811
310	1	2.7	310	300	1.007
320	2	5.4	324	348	1.023
330	-	-	-	-	-
340	1	2.7	340	375	0.954
350	-	-	-	-	-
360	2	5.4	366	474	0.967
370	1	2.7	372	435	0.845
380	2	5.4	382	575	1.032
390	1	2.7	394	580	0.948
400	5	13.6	404	692	1.049
410	1	2.7	413	850	1.206
420	2	5.4	425	770	1.003
430	1	2.7	432	900	1.116
440	1	2.7	443	1000	1.150
450	2	5.4	453	940	1.012
460	2	5.4	463	950	0.957
470	1	2.7	475	1050	0.979
480	-	-	-	-	-
490	-	-	-	-	-
500	-	-	-	-	-
510	1	2.7	515	1375	1.006
520	1	2.7	520	?	?
530	1	2.7	533	1425	0.941
540	-	-	-	-	-
550	1	2.7	553	1400	0.827
560	-	-	-	-	-
570	1	2.7	574	1600	0.846
580	1	2.7	585	1529	0.764
590	1	2.7	590	1700	0.827
600	1	2.7	600	1650	0.763
610	-	-	-	-	-
620	1	2.7	623	1860	0.769
630	-	-	-	-	-
640	-	-	-	-	-
Total	37*	100			

2001 Length Interval (mm)	n	%	Mean Length (mm)	Mean Weight (g)	K
200	-	-	-	-	-
210	-	-	-	-	-
220	-	-	-	-	-
230	-	-	-	-	-
-					
300	-	-	-	-	-
310	-	-	-	-	-
320	1	5	325	325	0.946
330	-	-	-	-	-
340	-	-	-	-	-
350	1	5	351	375	0.867
360	1	5	366	500	1.019
370	-	-	-	-	-
380	-	-	-	-	-
390	1	5	390	625	1.054
400	1	-	407	700	1.038
410	-	-	-	-	-
420	1	5	427	775	0.995
430	1	5	432	850	1.054
440	-	-	-	-	-
450	1	5	452	1100	1.191
460	3	15	463	1050	1.058
470	-	-	-	-	-
480	1	5	485	1000	0.876
490	1	5	497	1375	1.120
500	2	10	503	1337	1.051
510	-	-	-	-	-
520	-	-	-	-	-
530	-	-	-	-	-
540	-	-	-	-	-
550	1	5	559	1700	0.973
560	-	-	-	-	-
570	1	5	575	2000	1.052
580	1	5	588	1550	0.762
590	-	-	-	-	-
600	-	-	-	-	-
610	-	-	-	-	-
620	-	-	-	-	-
630	-	-	-	-	-
640	2	10	644	3037	1.137
Total	20	100			

* One fish captured in 2000 partially eaten by gulls not included here

Table 10: Comparison of some statistics from anadromous and non-anadromous Arctic Char captured in the Thomsen River in 2000 and 2001.

	Fork Length (mm)	Weight (g)	Sex	Age	Condition	Stomach condition	Year of capture
Non-anadromous	503	1300	Female	13	1.021	Partial	2001
Non-anadromous	497	1375	Male	10	1.120	Full	2001
Non-anadromous	559	1700	Male	13	0.973	Full	2001
Non-anadromous	485	1000	Female	19	0.876	Full	2001
Non-anadromous	351	375	Male	6	0.867	Empty	2001
Non-anadromous	623	1860	Male	24	0.769	Empty	2000
Anadromous	575	2000	Female	13	1.052	Partial	2001
Anadromous	642	2875	Male	12	1.086	Empty	2001
Anadromous	645	3200	Male	12	1.192	Empty	2001
Anadromous	503	1375	Female	13	1.080	Empty	2001
Anadromous	553	1400	Female	10	0.828	Not checked	2000

Table 11: Location, species and number of fish captured at all Thomsen River locations combined during 2000 and 2001.

Location	Species	Number captured	Latitude	Longitude
Sarfarssuk River mouth	Arctic Char	2	73°13'	119° 32'
Tributary to Sarfarssuk River	Ninespine Stickleback	17	73° 13'	119° 32'
Tributary upstream of Green Cabin	Ninespine Stickleback	4	73° 13'	119° 32'
Green Cabin, Thomsen River	Arctic Char	40	73° 13'	119° 32'
	Lake Trout	3		
	Least Cisco	35		
Near mouth of Dissection Creek	Arctic Char	1	73° 15'	119° 36'
	Least Cisco	3		
Unnamed tributary	Ninespine Stickleback	1	73° 18'	119° 43'
Near mouth of Whitesand Creek	Arctic Char	3	73° 24'	119° 36'
	Least Cisco	1		
Camp #1	Arctic Char	6	73° 21'	119° 38'
(Approx. 15 km downstream of Green Cabin)	Lake Trout	2		
	Least Cisco	16		
Camp #2	Arctic Char	1	73° 26'	119° 46'
	Lake Trout	5		
	Least Cisco	8		
Upstream of Shoran Lake (drying pools)	Ninespine Stickleback	5	73° 29'	119° 50'

East of Shoran Lake	Lake Trout	1	73° 31'	120° 04'
	Least Cisco	3		
Tributary near Baker Creek	Arctic Char (YOY/juveniles)	4	73° 29'	120° 01'
	Ninespine Stickleback	12		
Downstream of Shoran Lake	Arctic Char (YOY/juveniles)	3	73° 34'	120° 02'
	Lake Trout	1		
	Ninespine Stickleback	1		
Near mouth of Baker Creek	Lake Trout	5	73° 37'	120° 04'
Tributary near Baker Creek	Arctic Char (YOY/juveniles)	152	73° 38'	119° 58'
	Ninespine Stickleback	79		
Near mouth of Able Creek	Arctic Char	1	73° 43'	119° 55'
	Lake Trout	4		
	Least Cisco	2		
	Least Cisco (YOY)	6		
Muskox River (drying pool)	Least Cisco	1	73° 48'	119° 53'
Downstream of Muskox River confluence	Arctic Char	2	73° 49'	119° 52'
	Lake Trout	2		
	Least Cisco	39		
Unnamed tributary	Ninespine Stickleback	20	73° 53'	119° 46'
Island (Castel Bay)	Arctic Char	2	73° 59'	119° 42'
	Lake Trout	1		
	Least Cisco	38		
	Fourhorn Sculpin	2		